TWENTY-FIRST

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1902.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

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Presented to both Houses of Parliament by Command of His Majesty.

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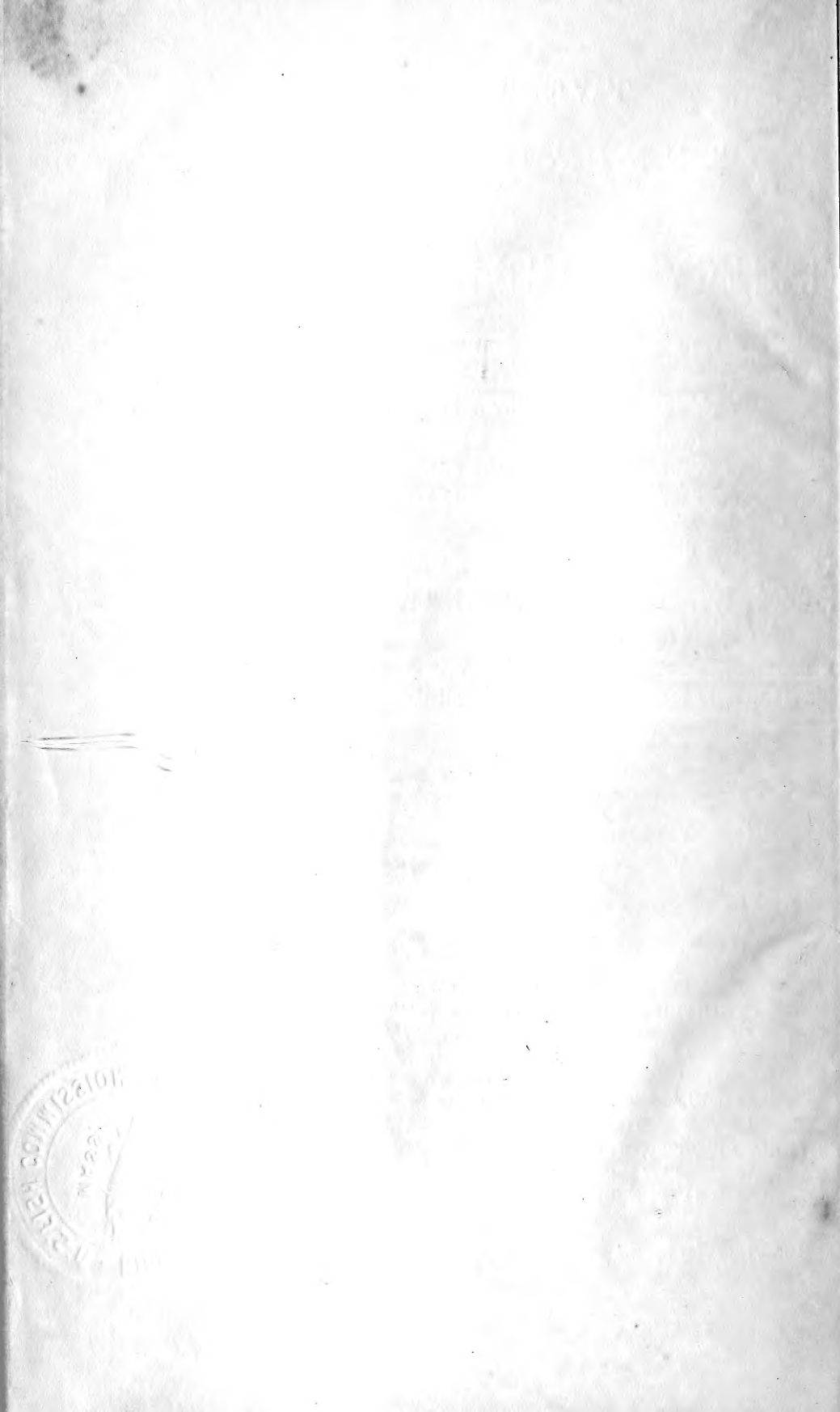

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TWENTY-FIRST ANNUAL REPORT.

TO THE RIGHT HONOURABLE

LORD BALFOUR OF BURLEIGH,

His Majesty's Secretary for Scotland.

OFFICE OF THE FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, *3rd June*, 1903.

MY LORD,

In continuation of our Twenty-first Annual Report, we have the honour to submit—

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

This part of the Twenty-first Annual Report contains an account of the scientific investigations conducted by the Board in 1902 in connection with the sea fisheries of Scotland, so far as the same have been completed. In previous Reports it was explained that owing to the small size and unseaworthy qualities of the *Garland* it was scarcely possible to carry on the investigations in the off-shore waters, on the fishing grounds from which the bulk of the fish supply is drawn; and also that for the same reasons the experiments and observations in the Moray Firth and other areas had been hampered and curtailed. The *Garland* was at length disposed of in the course of last year.

His Majesty's Government have now agreed to take part, together with the other nations of northern Europe, in a systematic investigation of the North Sea and adjacent waters, with a view to the elucidation of various problems connected with the Fisheries. The British share in this International Investigation has been divided into two parts, and the Board, at the request of His Majesty's Government, has undertaken the control of the northern half. The International Programme includes hydrographical

investigations and practical fishery experiments, and also lays particular stress on the compilation and study of precisely such statistics of our fisheries as it is the practice of the Board to prepare. Professor D'Arcy W. Thompson, the Scientific Member of the Board, has been appointed Director of these investigations. Scientific work apart from this International Programme, including the maintenance of the hatchery at the Bay of Nigg, will be continued by the Board under the superintendence of Dr. T. Wemyss Fulton.

Meanwhile, and pending the completion of arrangements for the new work, trawling experiments in the Moray Firth and Aberdeen Bay have been carried on by utilising the services at intervals of the large commercial steam-trawlers, equipped with the most efficient otter-trawls, and with very satisfactory results.

Investigations on Board Trawlers.

These, as stated above, were carried on in 1902 as in the preceding year, the localities examined being Aberdeen Bay in its whole extent, and the chief fishing grounds in the Moray Firth, particularly Burghead Bay and adjacent parts on the south coast, the Dornoch Firth, the grounds of the coast of Caithness, Smith Bank, and the deeper water areas known as the Witch Grounds. Two voyages to the offshore grounds were also made, one to those lying east and south-east of the Shetland Islands, and another to the Great Fisher Bank and the waters off the Buchan coast. The results are described in a paper in the present Report by Dr. T. Wemyss Fulton, the Scientific Superintendent, and the records of the hauls are given in a series of Tables.

In May the grounds in Aberdeen Bay were found to be comparatively unproductive, and the same condition prevailed at the various grounds examined in the Moray Firth, Burghead Bay, off Lybster, Smith Bank, and off Cromarty. At Burghead Bay, for example, the aggregate number of fishes taken in fifteen hauls, representing sixty-two-and-a-half hours of actual fishing, was 14,257, of which 10,301 were marketable. The average number taken per hour's fishing, with the largest otter-trawl in use, was thus scarcely 165 fishes of all kinds. The deep-water grounds off the Shetlands were found to be more productive in the same month, ten hauls. representing fifty hours of actual fishing, yielding 18,634 fishes, or at the rate of 372·7 fishes per hour's fishing, the same vessel being employed, and of the aggregate number 14,984 were marketable. A little later, at the end of May and beginning of June, a series of nine completely recorded hauls on the Great Fisher Bank, representing thirty hours' fishing, furnished only 4,096 fishes, or at the rate of 113·8 fishes per hour—less, therefore, than in the Moray Firth. The proportion of the different kinds of fishes in the various areas differed considerably—plaice, for instance, being well represented in the Moray Firth, present in fair numbers on the Great Fisher Bank, and absent on the deep-water grounds; their presence or absence as a rule has an important bearing on the profitable or unprofitable results of the fishing. The Moray Firth was also found

to be unproductive in October and on various occasions since, both in regard to the abundance of marketable fishes and to the profitable nature of the fishing compared with the offshore grounds.

On one of the occasions the trawler was equipped with a beam-trawl as well as an otter-trawl, in order to allow comparison to be made of the relative efficiency of the two nets on the same ground at the same time, but in the second haul with the beam-trawl the net was lost. The results of the first drag support the statement previously made that the horizontal spread of the otter-net does not greatly exceed the width of the beam-trawl, but fishes higher from the bottom. It is thus relatively less efficient for the capture of flat-fishes than of round-fishes.

The Relative Abundance, Distribution, and Migrations of the Food Fishes.

In the present Report the results of the investigations made on board trawlers regarding the distribution and relative abundance of the food fishes at different sizes, and the extent of their migrations, are described by Dr. T. Wemyss Fulton. Among the flat-fishes certain species which begin their life in the shallow water, or on the beaches, move out when older into deeper water, and may be obtained in diminishing numbers at considerable distances from land. Thus the plaice appears to pass its early stages exclusively in the shallow water near shore, while the older forms, ranging about twenty inches in length and not under fourteen inches, were got in fair numbers in sixty-five fathoms, from eighteen to twenty miles from Fair Isle, and in smaller numbers in water of the same depth, sixty-five miles from Sumburgh Head, which was the nearest land. None of these fish were under about three years of age. The adult plaice were found in still greater abundance on the Fisher Bank, in the middle of the North Sea, in thirty-four fathoms. In all these localities the plaice present must have migrated very considerable distances in the course of their growth, in the latter instance probably from the Danish coast *via* the Dogger Bank, and this agrees with the results of the marking experiments. Observations on the rate of movement of the plaice in the large tidal pond at the Bay of Nigg show that when leisurely swimming they may travel considerably over a mile in one hour.

The turbot was also occasionally found far from shore in deep water, and it also begins life in shallow water; while the brill is more restricted in its range. The dab, on the other hand, not so strictly confined in its early stages to the shallow water, was found further offshore in deeper water than the plaice, but, like the latter, in greatly diminished numbers.

The observations in regard to the round-fishes also indicate an extensive wandering or migration. It was found that as a rule the adult cod were more numerous relatively and absolutely on the inshore grounds, that the larger codling were more abundant offshore, and that the smaller codling under two years of age were

much scarcer on the deep-water grounds than inshore. The absence or great rarity of the young forms of some other species, as the saithe or coal-fish, the hake, pollack, and ling, in the latter area, while they are known to be common in many cases near land, also indicates an extensive wandering. An inshore winter migration of cat-fish was also established. The results generally tend to show that the extent of the migratory movements of even such relatively sedentary forms as flat-fishes is much greater than has been commonly supposed, and that the predatory round-fishes may traverse great distances. They suggest, moreover, that by extended observations of the kind, whether on board fishing vessels or the steamers engaged in the International Survey, it would be possible within a limited time to prepare charts showing with considerable accuracy the extent of the distribution and of the wanderings of all the bottom fishes in the North Sea and adjoining areas, as well as the facts relating to the place and period of spawning.

The Hatching and Rearing of Food Fishes.

During the hatching season in 1902 the number of fertilised eggs of the plaice obtained from the spawning pond was 72,410,000, or about seven millions more than in the previous year, and 29,120,000 more than in 1900. The number of fry which were hatched and retained in the apparatus until approaching the post-larval stage amounted to 55,700,000, and these were liberated off the coast of Aberdeenshire and in Loch Fyne. At the end of the previous season the number of adult plaice in the pond in good condition was 767, most of which continued to thrive during the summer and autumn. To these, others, obtained from the vessels engaged in the trawling investigations, were added later, bringing the breeding-stock up to about one thousand plaice of both sexes.

In the latter part of January the temperature of the water in the spawning-pond was rather lower than usual, and few eggs were observed to have been shed until the early part of February. The first collection was made on the 8th of that month, and after a check in the spawning due to a severe frost, when the temperature of the water sank to freezing-point, the number of eggs gradually increased until in the first half of March more than two millions, and occasionally nearly three millions, were taken from the pond daily. Thereafter the number diminished, and the last collection was made on the 25th April.

The considerable increase in the productiveness of the hatchery in recent years is due to the more ample and suitable arrangements existing at the Bay of Nigg, and particularly the provision of a large tidal spawning pond, in which a good breeding stock can be maintained throughout the year. The natural conditions and facilities for the work, and the abundant supply of sea-water of good density and purity, have also assisted in the result. At the same time the expense has been reduced, largely owing to the supply of water to the tank being tidal, whereby the need of pumping is greatly diminished, and the combination of the hatchery

with the laboratory. Apart from the cost of the distribution of the fry, the expenditure on the hatching work is now under £100 per annum, and the total expenditure does not greatly exceed that sum.

Besides the hatching of the plaice above referred to, the hatching of lobsters and crabs was also undertaken by Dr. H. C. Williamson at the request of the fishermen on the coast of Aberdeenshire. About 4,500,000 larvæ of the crab, and three thousand young lobsters—most of which were reared through several stages, and in some cases nearly to the stage at which the adult form is assumed—were liberated along the coasts of Aberdeen and Banffshire. In the case of the plaice, it may be explained, the time during which the embryonic and larval fishes are protected extends to about half the period of their pelagic life, at the end of which they settle on the bottom as young flat-fishes.

Since the hatchery was established the number of the fry of the food fishes which have been produced at it amounts to 303,752,000—viz., 286,855,000 plaice, 5,727,000 lemon soles, 5,160,000 turbot, 4,010,000 cod, and 2,000,000 of others. Of the plaice, 136,065,000 were produced at Dunbar, when the hatchery was situated there, and 150,790,000 at the Bay of Nigg since 1900.

The Development of the Crab.

The present Report also contains a paper by Dr. H. C. Williamson on the larval and early young stages of the common shore crab (*Carcinus mœnas*), in which the developmental changes that occur are traced with great care and minuteness. It is complementary to another paper on the edible crab contributed by the same naturalist to the Nineteenth Annual Report. The character and structure of the various appendages in the Zoëa stages and in the Megalops are fully described and illustrated by a large series of figures, and the features which distinguish these stages from the corresponding stages of other forms are detailed. The development of the branchiæ or gills is very fully treated. A number of observations were also made in regard to the reproduction, the rate of growth, and the moulting of the crustacean in question. The duration of the period of incubation of the eggs has not yet been determined, but it probably exceeds four months.

The period of hatching extends over a considerable number of months—viz., from March to the end of July—and berried females may be got on the beach between tide-marks during nearly the whole year with the eggs of different females in very different stages of development. The eggs are at first straw-coloured, becoming deep-amber as development proceeds, and dirty-grey before hatching. The larval crab leaves the egg in the so-called Protozoëa stage, which is transitory, the delicate integument being immediately cast, and it then appears as a Zoëa, of which there are four stages, each following a moulting. At this time it is wholly pelagic, or free-swimming, a mode of life which appears to last for about a month or a little less. The next moult gives rise to the

Megalops, which is a connecting link between the pelagic Zoëa and the demersal young crab, which lives on the bottom, partaking of the character of both, being adapted either for swimming or crawling, and this finally gives rise to the young crab.

With reference to growth, it was found that a considerable amount of variation occurred, due to the fact that increase in size only takes place after a moult, and the amount of the increase varies not only with the individual, but also in the same specimen in different moults. It is, however, possible with a fair amount of certainty to separate the crabs into yearly groups if attention be given, in the case of small crabs, to the month in which they are captured. Observations have also been made on the amount of growth that takes place in successive moults of specimens kept in confinement; and Dr. Williamson's observations in this respect were supplemented by a valuable series of cast shells from Mr. H. T. Waddington, Bournemouth. The conclusions reached are that the shore crab, when one year old, may measure from about one-third of an inch to nine-tenths of an inch in breadth, the average being a little over half-an-inch. When two years old the average breadth of the male is about two inches, and of the female nearly one inch and three-fifths; when three years of age the male is about two-and-two-fifths of an inch broad, and the female about one-fifth of an inch less. The number of moults in a year was found to vary considerably.

The Invertebrate Fauna.

The collections of crustacea which have been made in the course of the fishing investigations have proved of considerable interest, and in the present Report Dr. Thomas Scott contributes a further paper dealing more particularly with the Copepoda. These minute forms play an important rôle in connection with the food of fishes. They exist in enormous multitudes and constitute one of the chief agencies by which the primary source of food, namely plant-organisms, is transformed and rendered available for the nutrition of fishes. Many fishes, as the herring and the sprat, the anchovy, the mackerel, and the pilchard or sardine, subsist mainly upon copepoda, while almost all other fishes live upon them in their young and early stages.

In the present paper Dr. Scott describes a large number of species, of which thirteen, belonging to eight genera, are new to science, the descriptions being illustrated by a series of drawings. In some instances the determination of these minute forms is of importance for other reasons, as in tracing the course of sea-currents. Thus, for example, one species which is described, *Eucalanus crassus*, was obtained about ten miles off Aberdeen, and was previously recorded from the Moray Firth, from the region south-east of Fair Isle, and from the Faröe Channel. Its distribution is known to extend as far south as the Gulf of Guinea, and its appearance in the Moray Firth and off the East Coast probably indicates the presence of Atlantic water. It is interesting to note that all the specimens were taken in October and November.

The Distribution, Food, and Growth of the Angler.

In another paper Dr. Wemyss Fulton describes the results of an investigation of the distribution, rate of growth, and food of the angler or frog-fish (*Lophius piscatorius*), one of the principal enemies of the edible fishes. In the course of the trawling investigations conducted on board steam-trawlers fishing from Aberdeen, 1956 specimens were taken, of which 1549 were caught in the Moray Firth. The proportional abundance of this fish was found to be greater in Aberdeen Bay and the Moray Firth than in the more distant grounds in deeper water off the Shetlands. As is the case with so many other fishes, the young forms were absent from the collections or only scantily represented, a circumstance believed to be mainly due to their preference for rocky and rough ground, where algæ grow and furnish shelter and protection, and where the trawl cannot be used. The smallest described was five inches in length, which is among the smallest on record.

The observations on the rate of growth were made by the comparison of a series of measurements of specimens taken at different seasons, and indicate that at an approximate age of six months the angler has a mean length of about six inches and three-eighths, at one year and six months a mean length of about a foot, and at two years and six months an average length of about eighteen inches. The males probably reach maturity when four years of age, and the females a year later with a larger size.

In determining the nature of the food the stomachs of 541 anglers were examined, and of these 261, or 48·2 per cent., were empty. Of the remainder, fish in some form or another were found in 269, cephalopods alone in ten, and a shore crab in one. The proportion of flat-fishes distinguished was 29·6 per cent., and of round-fishes 70·3 per cent., and it was found that the principal fishes preyed upon were whitings, sand-eels, haddocks, common dabs, and herrings, but the proportions varied on different grounds and at different seasons. Very few of the anglers contained large fishes in their stomachs. Even the largest seem to live for the most part on small and young fishes; some of the smallest of the anglers, however, had swallowed fishes almost as long as themselves. It is probable that the piscivorous habit is adopted at a very early stage.

The Food of Fishes.

Dr. Thomas Scott contributes to this Report a paper giving the results of his continued investigations on the food of fishes as determined by the examination of the contents of their stomachs. The food of twenty-two species of fishes is dealt with, including the cat-fish, the king-fish, the silver smelt, the Norway pout, skates, and dog-fishes. It is interesting to notice that the observations on the contents of the stomachs of the dog-fishes show that while these predaceous forms live to a large extent on the herring, they also prey upon round fishes and flat-fishes, the remains of whitings, coal-fish, dabs, and lemon soles being obtained in them.

The examination of the stomach of a small specimen of the common porpoise captured in the Bay of Nigg, in the vicinity of the Laboratory, showed how destructive these cetaceans may be among the food fishes. Besides the partly-digested remains of fishes, apparently whitings, it contained the ear-bones of about one hundred and forty whitings, as well as those of other gadoids, which had been evidently eaten and digested a short time previously. On the other hand it was found that the king-fish (*Lampris luna*) lived chiefly on cephalopods, the horny jaws of fifty-four being found in the stomach of one specimen.

We have the honour to be,

Your Lordship's most obedient Servants,

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
D'ARCY W. THOMPSON.
W. R. DUGUID.
L. MILLOY.
D. MEARNS.

WM. C. ROBERTSON, *Secretary.*

SCIENTIFIC REPORTS.

I.—INVESTIGATIONS ON THE ABUNDANCE, DISTRIBUTION AND MIGRATIONS OF THE FOOD FISHES. By Dr. T. Wemyss Fulton, F.R.S.E., Scientific Superintendent. (Plate I.)

Contents.

In the Annual Reports for last year and the year preceding, an account is given of certain investigations which were made, for the most part by the use of steam trawlers, as to the abundance and distribution of the food fishes on certain grounds, and more particularly in the Moray Firth and Aberdeen Bay.

In 1902 these investigations were continued, but, owing to the reduction in the amount of the scientific vote, on a smaller scale than in the previous years. Visits were made to the various grounds in the Moray Firth, a series of hauls being taken in the Dornoch Firth, Burghead Bay, Smith Bank, and other places which had been examined on previous occasions, as well as in Aberdeen Bay. Two trips were also made to the more distant fishing grounds, the Great Fisher Bank, and the north-eastern area off the Shetlands, and much valuable information

has been acquired both as to the abundance of the different species of food fishes present on the grounds at the time, and in regard to their distribution in the various areas, and their natural history generally. The particulars in regard to the hauls and the number of fishes obtained were carefully recorded, and will afford important means for comparison in succeeding years. The fishes, as before, were classified, according to the practice adopted on board the trawling vessels, into marketable and unmarketable, and the details are given in a series of Tables appended, and are discussed below.

I. Investigations on Board Steam Trawlers.

1. The Moray Firth and Aberdeen Bay in May.

The first of the series of investigations was made in Aberdeen Bay and the Moray Firth in May, the trawler employed being the "Star of Peace," under Captain Alexander Caie, and Dr. H. C. Williamson was good enough to accompany her and to record the catches.

The first haul was made in Aberdeen Bay, between Belhelvie and the "Black Dog," on the afternoon of 12th May, the depth of water being eleven fathoms, and it lasted for four hours and twenty minutes. Except for plaice and dabs the catch was a very poor one, only six haddocks being taken. The aggregate number of fishes was 1906, of which 1382 were marketable and 524 unmarketable. The marketable fishes were represented by six cod, six haddocks, 713 plaice—242 medium and 471 small,—653 common dabs, and four flounders. The unmarketable consisted of five whitings, thirteen plaice, 363 common dabs, forty-seven gurnards, sixty-eight anglers, and eighteen skates and rays.

A second drag in the same locality for four hours and a quarter, in from ten to fourteen and a half fathoms, was much less productive, only 674 marketable fishes being taken, and 424 unmarketable, the total being 1098. Among the marketable were fourteen cod, a saithe, 216 plaice—eight large, 106 medium, and 102 small,—427 dabs, and thirteen flounders. Only three small and unmarketable haddocks were taken and eighteen unmarketable whitings. There were fifty-one skates and rays and forty anglers among the unmarketable fishes, as well as one herring. The wind during the day had been blowing very hard from N.N.E., and the sea was very choppy.

A third haul, only partly enumerated, made in from eleven to eighteen fathoms, for four hours and ten minutes, yielded 26 cod, nine marketable codling, five haddocks, seven whitings, five coal-fish, one and three-quarter baskets of plaice, as well as two brill and a basket of marketable dabs. The offal or unmarketable fishes filled half a basket, and were chiefly dabs.

Other three hauls were made in Aberdeen Bay with even less success, haddocks being practically absent and plaice very scarce. The aggregate number of fishes obtained in the three hauls which were completely recorded, representing twelve hours and thirty-five minutes' fishing, was 3361, of which 2351 were marketable and 1010 unmarketable. The numbers of the various kinds were as follows, the marketable being indicated by I. and the unmarketable by II. :—

[Table

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Coal-fish.
I.	39	10	6	.	.	1
II.	.	.	3	24	66	.
	39	10	9	24	66	1

	Plaice.	Lemon Dab.	Common Dab.	Brill.	Flounder.	Long Rough Dab.
I.	1,073	1	1,196	1	18	.
II.	20	.	689	.	12	8
	1,093	1	1,885	1	30	8

There were also taken fifteen grey skates, eight thornbacks, and fifty-six starry rays, as well as 109 anglers and six herring.

A haul for sixty-five minutes was also made at the Dog Hole, off Aberdeen, in fifty-five fathoms, and 133 fishes were taken in the otter-net, 122 being marketable. The marketable catch comprised one cod, fifteen codling, twenty-four haddocks, twenty whitings, two ling, a saithe, four plaice, forty-two lemon dabs, two common dabs, and eleven megrims, and there were also seven unmarketable starry rays, one grey skate, and three anglers. The small-meshed net around the otter-trawl contained a number of small whitings, haddocks, a few codling, two gurnards, a small angler, and an armed bull-head.

On the 15th the vessel began work in the Moray Firth, the first haul being made at Burghead Bay in from ten to fifteen fathoms, and it lasted for four hours. The catch comprised 1319 fishes, 1043 of which were marketable and 276 unmarketable. Among the former were four cod, four codlings, 349 haddocks—fifty-one large, forty-six medium, and 252 small,—forty-seven whitings, seventy-six gurnards, and five cat-fishes. Plaice numbered 322, the majority being small, and there were nine lemon dabs, 160 common dabs, and fifty-nine witches, as well as one brill. The unmarketable consisted mostly of dabs, with some gurnards and whitings. Although the number of fishes was fairly large the catch was not a valuable one, owing to the paucity of good haddocks and plaice.

A second drag in the same locality, although yielding a somewhat greater number of fishes, was not more profitable. The total was 1680, of which 1294 were marketable and 386 unmarketable. The haddocks numbered 264, but there were only sixty large and twenty mediums among them, the remainder being small. Of 419 plaice taken, only nine were large and thirty-three medium. There were also two cod, ten cat-fishes, six witches, four lemon dabs, and 537 marketable common dabs. The bulk of the unmarketable fishes consisted of dabs, gurnards, and anglers, of which thirty-seven were caught.

The vessel then shifted its ground westwards to off the Suters of Cromarty, where a haul for two hours and forty-five minutes in from eight to twelve fathoms of water yielded only 784 fishes, of which 633 were marketable. The principal result of the change was an increase in the number of codlings and witches taken and a few more haddocks, but plaice were scarcer than before, totalling only seventy-nine, of

which three were large, seventeen medium, and the remainder small. The haddocks numbered 325, of which 124 were large, forty-one medium, and 160 small. There were also two cod, seventy-two marketable codlings, twenty-seven whitings, sixteen gurnards, sixty-two common dabs, thirty-three witches, as well as twelve lemon dabs and two cat-fishes.

The vessel again returned to Burghead Bay and made a series of hauls on the same grounds as before, with even poorer results, the catches varying from 812 to 205 marketable fishes. The plaice which were of marketable size varied from 128 to 405, and the marketable haddocks from one to seventy-nine.

The coast of Caithness was then visited and a drag made off Lybster, in from twenty to twenty-five fathoms, for four hours and five minutes. The number of fishes caught was 1044, of which only 356 were marketable, the chief feature being the abundance of gurnards as well as the scarcity of plaice and haddocks. The marketable fishes comprised three cod and thirty-three codlings, 109 haddocks, only nine being large and sixteen medium, 102 whitings, a cat-fish, twenty-seven marketable gurnards, sixty-five plaice, all but twenty being small, a halibut, and fifteen common dabs.

Steaming to Smith Bank a drag was made in from twenty-one to thirty fathoms on the northern edge for four hours and ten minutes, and 1706 fishes were taken, of which 804 were gurnards. The marketable fishes numbered 847, comprising two cod, five codlings, 394 haddocks, forty-six of which were large and eighty-seven of medium size, forty-three whitings, three cat-fishes, 185 gurnards, three halibut, a turbot, a brill, eighty lemon dabs, three witches, nineteen common dabs, and 106 plaice, eighty-four being mediums. There was thus a considerable variety in the fishes, but none of them were obtained in large numbers.

The vessel then ran to Burghead Bay again and made other four hauls on the 19th and 20th with slightly better results than on the previous occasion. The first yielded 899 marketable fishes and 286 unmarketable, the number of plaice being 344, while the haddocks comprised only seventeen. In the second drag 817 marketable fishes were obtained, including 277 plaice and thirty-four haddocks. In the third the number of the marketable fishes was 988, of which plaice amounted to 329 and haddocks to 49. In the fourth, which was the best, 809 marketable fishes were secured, including 470 plaice—thirty-four being large and 261 medium,—and forty-nine haddocks.

The aggregate number of fishes obtained in Burghead Bay as the result of fifteen hauls, representing sixty-two and a half hours of fishing, was 14,257 : the number of the marketable was 10,301, or at the rate of scarcely 165 fishes of all kinds per hour. The particulars are given in the following Table, the marketable being indicated by I., and the unmarketable by II. :—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Coal-fish.	Cat-fish.
I.	55	41	1,054	226	1,372	1	68
II.	.	63	109	101	574	.	.
	55	104	1,163	327	1,946	1	68

[*Continued.*

	Plaice.	Lemon Dab.	Witch.	Common Dab.	Flounder.	Halibut.	Turbot.	Brill.	Long Rough Dab.
I.	4,456	80	202	3,639	1	1	16	24	.
II.	136	10	.	2,436	.	.	.	.	24
	4,592	90	202	6,075	1	1	16	24	24

2. The Deep-Water Grounds in May.

A trip to the north-eastern deep-water grounds off the Shetlands was made at the end of May on board the "Star of Peace," the recorder of the hauls being on this occasion Mr. W. Mason, one of the men of the "Garland," who was accustomed to similar work on board that vessel. Leaving on the 22nd of the month the trawler made for Buchanness, as usual when going to the grounds named, and then laid her course N.E. by E. easterly, and ran about 111 miles by the log. The position where fishing was begun lies about 80–85 miles S.S.E. of Sumburgh Head, Shetland, in the upper part of Square XIX. on the chart (Plate I.).

The first drag was made in 67½ fathoms, the surface temperature being 44° F., and the bottom-temperature 42·8° F. The five hours' haul on a soft bottom gave 2650 fishes, of which 2100 were marketable and 550 unmarketable. Haddocks were most numerously represented, 1445 being taken, almost all marketable; codlings and witches were also present in fair numbers, there being 130 of the former and 322 of the latter. As usual, the most abundant of the unmarketable forms was the long rough dab, of which 517 were caught. Four hauls were made in this locality, each for five hours, the depths being 67½, 68½, and 70 fathoms. The total number of fish caught in three of the hauls, which were fully recorded, was 7654, of which 6044 were marketable and 1610 unmarketable, the average take per hour's fishing being 510·3 fishes, and the proportion of unmarketable to the total catch 21 per cent. The numbers of the various species were as follows, the marketable being indicated by I., and the unmarketable by II.:—

	Cod.	Codling.	Haddock.	Whiting.	Ling.	Saithe.	Tusk.	Hake.	Cat-fish.
I.	15	279	4,502	500	3	5	4	1	4
II.	.	.	3	.	1	.	.	.	2
	15	279	4,505	500	4	5	4	1	6

	Gurnard.	Witch.	Megrim.	Long Rough Dab.	Common Dab.	Lemon Sole.	Grey Skate.	Starry Ray.
I.	4	708	15	.	.	2	2	.
II.	2	34	.	1,513	3	1	.	42
	6	742	15	1,513	3	3	2	42

There were also taken in these hauls seven anglers, one dog-fish, and one Norway haddock (*Sebastes*). Another trawler was working in the vicinity.

Although the gross number of haddocks in these hauls was fairly good for the season, they consisted mostly of the small or third selection, the large haddocks and those of medium size, which bring much better prices, being rather scantily represented ; there were 929 large, 697 medium, and 2876 small. At this season of the year, as previously remarked, the large haddocks after spawning are difficult to locate in numbers, and are believed to disperse and leave the bottom. None of the haddocks observed were spawning. It was therefore decided to shift ground, and the vessel steamed about 45 miles N. $\frac{1}{4}$ E. from where the last of the four hauls was taken, to a position approximately about fifty miles E. by S. of Sumburgh Head, in Square XV. (Plate I.). A haul was made here on the morning of the 24th May, in seventy-one fathoms—also for five hours,—but the catch was small, comprising 1611 fishes, of which 1375 were marketable and 236 unmarketable. Whitings were more numerous, and twelve cat-fish, six hake, five coal-fish, a halibut, and ninety-one gurnards were included ; but haddocks, and also witches, were scarcer than before. Numbers of whitings were ripe, and the stomach of a coal-fish was found to contain two argentines, a haddock, and two specimens of *Gadus Esmarkii*.

The trawl was again dropped, in seventy-six fathoms, and the vessel steered N.E. by E. for the five hours, the distance run being reckoned to be a little over ten miles. Another trawler was working alongside; there was a fresh breeze from the westward and a heavy swell on the sea. The catch amounted to 3101 fishes, of which 2684 were marketable and 417 unmarketable. It included a comparatively large number of megrims, viz. 167, two saithe or coal-fish, six hake, four ling, eight cat-fish, and a tusk, and haddocks were more numerous than in the previous haul, but the large ones were poorly represented, and only twenty marketable witches were obtained. Twenty-nine starry rays were taken.

The next haul was made in seventy-one fathoms, and much the same course was steered during the five hours' drag, viz. N.E. The catch in this instance was only partly enumerated ; it included seven hake, two ling, one coal-fish, twenty-three starry rays, five common dabs, and eight-and-a-quarter baskets of haddocks.

The eighth haul was made early in the morning of the 25th May, in seventy-eight fathoms, and during the first half of the five hours the course steered was N.E. by E. The catch included six cod, eleven hake, three ling, two tusk, a cat-fish, a halibut, three common dabs, 122 witches, and twenty-one marketable megrims; but only 606 haddocks were secured. A few of the haddocks were observed to be still spawning. The total number of fishes obtained was 1394.

When the net was brought up the vessel was run for about fifteen miles to the south-west, and then hove to until the morning of the 26th owing to the heavy sea and south-west gale. The wind previously had been blowing a moderate breeze from the S.W., W., and W.S.W., and the sea was choppy ; and the above drag was made in a moderate gale from north-west to south-west. On the morning of the 26th, the gale having moderated, the wind hauling to north-west, the trawl was shot in sixty fathoms on a shelly bottom, and the course steered during the drag was north-east. On taking the latitude at the end of the haul it was found to be 60° 2′ N., and the vessel was therefore in the southern part of Square XI. (Plate I.). Another trawler was observed fishing in the E.S.E.

The catch was a poor one, the number of fishes obtained being 918, of which 782 were marketable; the net, however, was slightly split Four cod, seventy-two codlings, one saithe, eight cat-fish, and one halibut were among the fishes caught, but haddocks continued to be scarce, only 511 being taken (260 large), and only sixteen witches and three megrims were secured. The somewhat shallower water of this haul was responsible for two plaice being taken and a larger number than usual of common dabs, viz. seventy-eight. A few haddocks and many whitings were found to be spawning.

The tenth haul was made in the same locality, the depth being fifty-eight fathoms, the wind blowing a moderate breeze from the west, and the sea continuing choppy. The five hours' drag resulted in a catch of 1340 fishes, of which 1149 were marketable, comprising four cod, 154 codling, 637 haddocks, 265 whitings, four ling, one hake, two tusk, two coal-fish, nine cat-fish, but only thirty-two witches and four megrims. Plaice were again present, viz. three, as well as three lemon soles, eighty-three common dabs, and eighteen starry rays.

The eleventh haul was made in sixty-three fathoms in the same locality, the bottom being sandy. The catch was not fully enumerated, but it included a basket of codling, two cod, six-and-three-quarter baskets of haddocks (four of large), a basket of whiting, a ling, a tusk, four cat-fish, a halibut, a megrim, eighteen witches, and one plaice, as well as seventy-two common dabs. As usual when considerable numbers of common dabs are taken in the deeper water, the long rough dab was less abundantly represented, only nineteen being taken.

Early in the morning of the 27th the trawl was again shot, in fifty-eight fathoms, the wind blowing a moderate breeze from S.S.W. After the lapse of five hours it was found on hauling that almost the entire net had been torn away, leaving the ground-rope and the boards attached—an illustration of the vicissitudes of trawling. The net had probably caught on rocks or wreckage. On sounding, the depth was found to be sixty-six fathoms, and the bottom sandy and rocky. The vessel then steamed thirty-two miles to the south-west in Square XV., the ground being supposed to be the western part of Bressay Shoal. Here the trawl was dropped in seventy-four fathoms, the bottom being muddy.

The catch consisted of 1670 fishes, 957 being marketable and 713 unmarketable. The marketable fishes included seven cod, ninety-two codling, 620 haddocks (258 large), one coal-fish, two tusk, one cat-fish, two halibut, 139 witches, and three megrims. There were no plaice, but five small lemon soles. Long rough dabs were abundant, the number taken being 672, while there were only five common dabs. One Norway haddock (*Sebastes*) was caught; one haddock was found to be spawning. The bottom-temperature was 42·9° F. and the surface-temperature 44·6° F.

The fourteenth haul was made in the same locality, on a muddy bottom, in seventy-three fathoms. A complete enumeration of the fishes caught was not made, but they included one-and-a-half basket of codlings, six-and a-quarter baskets of haddocks ($2\frac{3}{4}$ of large), three-quarters of a basket of whitings, eleven saithe or coal-fish, one cat-fish, one-and-a-half basket of witches, four grey skates, 327 long rough dabs, one common dab, one gurnard, two megrims, and twenty-nine starry rays.

The next drag was made in the same place in seventy-two fathoms, and 946 fishes were secured in the five hours. The number of marketable haddocks was 442; there were also three cod, forty-five marketable codlings, two coal-fish, two cat-fish, 109 witches, nine megrims, forty-three starry rays, 234 long rough dabs, and two common dabs.

The sixteenth haul was a short one, for thirty-five minutes, in seventy fathoms, on the morning of 28th May, and fifty-five fishes were taken, viz. forty-one haddocks, one cod, five codling, two whitings, and six witches.

The vessel then returned to Aberdeen, steering S.W., and running 140 miles to Buchan Ness.

In the voyage described above, the trawler prospected about more than is usual, owing to the scarcity of fish. As already mentioned, the movements of the haddocks are somewhat erratic at the close of the spawning season, and since this fish forms the most important item in the catches in the deep water, the trawlers hunt about in the hope of striking upon a shoal.

Complete records were made of ten hauls, representing fifty hours' fishing; the total number of hauls being sixteen, and the duration of actual fishing seventy-five hours and thirty-five minutes. One of the drags, as stated, was blank, on account of the loss of the net.

I have tabulated the detailed catches of the ten hauls referred to, in which an aggregate of 18,634 fishes was recorded, 14,984 being marketable and 3650, or about 19·5 per cent., unmarketable. The average number of fishes and of marketable and unmarketable taken in each of the five hours' hauls and in each hour's actual fishing are these :—

	Marketable.	Unmarketable.	Total.
Per Haul, . .	1,498·4	365·0	1,863·4
Per Hour, .	299·7	73·0	372·7

Although the fishing was comparatively poor on this voyage, it was much superior to what obtained farther to the south and south-east, and the "Fisher Bank," a week later (*see* p. 26).

The detailed catches show that of the marketable fishes 13,508 were round-fishes and 1465, or 10·8 per cent., were flat-fishes; while of the unmarketable 188 were round-fishes and 3273, or 89·7 per cent., were flat-fishes, composed almost entirely of long rough dabs.

The particulars referring to the flat-fishes are as follow; the marketable being indicated by I. and the unmarketable by II. :—

	Plaice.	Lemon Sole.	Witch.	Common Dab.	Long Rough Dab	Megrim.	Halibut.
I.	5	9	1,203	5	.	325	8
II.	.	1	50	217	2,994	11	.
Total, . .	5	10	1,253	222	2,994	246	8
Average per haul, .	0·5	1·0	125·3	22·2	299·4	24·6	0·8
Average per hour's fishing, . .	0·1	0·3	25·1	4·4	59·9	4·9	0·2

The most abundant of all the flat-fishes—and next, indeed, in aggregate numbers to the haddock and whiting—was the long rough dab, which gave an average of 299·4 per haul. This figure does not, however, represent anything like the true proportion of this fish present on the grounds, because only the larger individuals are taken in the ordinary otter-net, the great majority passing through the meshes; while, on the contrary, most of the megrims and witches on the grounds, as the experiments I previously made with small-meshed nets proved, are caught. Witches are next in numbers, giving an average of 125·3 per haul, and megrims third with 24·6. The common dabs, taking all the hauls together, gave an average of 22·2. Plaice were only got in a few of the hauls in the shallow water—fifty-eighty and sixty fathoms—the total number being five, or 0·5 per haul. Lemon soles were also uncommon, ten being taken, or an average of one per haul.

The corresponding details concerning round-fishes are these:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Saithe.	Hake.	Ling.	Tusk.	Catfish.
I.	49	972	9,054	3,146	172	18	25	14	13	45
II.	.	15	34	17	118	.	.	1	.	3
Total, . .	49	987	9,088	3,163	290	18	25	15	13	48
Aver. per haul,	4·9	98·7	908·8	316·3	29·0	1·8	2·5	1·5	1·3	4·8
Average per hour's fishing,	0·9	19·7	181·8	63·3	5·8	0·4	0·5	0·3	0·3	0·9

Cod were not numerous, only forty-nine being obtained, or 4·9 per haul, while the codling numbered 987, or an average of 98·7 per haul, the proportion being about twenty codlings to one cod. In the hauls farther south and on the Fisher Bank the proportion was much less. Haddocks, which formed about half of the whole catch, and considerably more than half of the marketable fish, numbered 9088, the average per haul being 908·8. The majority consisted of the third, or smallest, class. Whitings numbered 3163, the average per haul being 316·3. Gurnards were taken in eight of the ten hauls, the number in a haul ranging from two to ninety-one—the latter in seventy-one fathoms, —the aggregate being 290 and the average per haul 29·0.

Among the "long" fish obtained were eighteen saithe or coal-fish, twenty-five hake, fifteen ling, thirteen tusk, and forty-eight cat-fish, the respective averages per haul being 1·8, 2·5, 1·5, 1·3, and 4·8. Cat-fish were taken in each haul, the number in a haul varying from one to twelve; tusk in seven hauls, the number never exceeding three in any of them; coal-fish were got in eight hauls, the highest number in an individual haul being five; ling were taken in six hauls, the largest number being four; while hake were represented in five of the hauls, in numbers ranging from one to eleven.

Among skates and rays, the starry ray was most abundant, 157 being taken, or an average of 15·7 per haul; the numbers in individual catches varying from seven to forty-three, and some were got in nine of the drags. Twenty-seven anglers were caught, or 2·7 per haul. Amongst the other fishes were three Norway haddocks and two dog-fish.

The area over which these ten hauls were taken was considerable, as explained in the description of the movements of the vessel, above given, and the range in depth varied from fifty-eight to seventy-eight fathoms, a difference of twenty fathoms or 120 feet. I have therefore contrasted the catches of the two hauls in shallower water—fifty-eight to sixty fathoms—with five drags in from seventy-one to seventy-eight fathoms. The number of fishes obtained in the former was 2258, or an average of 1129 per haul; in the latter the number was 8722, or an average of 1744 per haul; in the former the average of marketable fishes was 965 and in the latter 1402.

The numbers and averages for the flat-fishes in the two groups are indicated in the following Table, (1) representing the hauls in the shallower water, and (2) those in the deeper water:—

	Plaice.	Lemon Sole.	Witch.	Common Dab.	Long Rough Dab.	Megrim.	Halibut.
(1) No.	5	5	49	161	78	9	2
Av.	2·5	2·5	24·5	80·5	39·0	4·5	1·0
(2) No.	. .	2	462	58	1,403	222	6
Av.	.	0·4	92·4	17·6	280·6	44·4	1·2

The difference in the two cases is considerable, but the nature of the bottom must also be taken into account. In the shallower water hauls it consisted of sand and shells, and in the deeper water, when noted, it was muddy. The deepest water in which plaice were procured during the voyage was sixty-three fathoms (haul No. 11), where one was obtained; the aggregate number during the trip was six. Lemon soles were procured in deeper water, one being got in seventy-four fathoms where the bottom was muddy, and another in seventy-three fathoms. Common dabs, much more numerous in the shallower water hauls, were also got in those in the deeper water, on a muddy bottom, but in much fewer numbers, and decreasing with the depth; thirteen were taken in a haul in seventy-six fathoms, and three in a haul in seventy-eight fathoms.

The particulars concerning the proportions of the round-fishes in the two groups of hauls are shown thus:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Saithe	Hake.	Ling.	Tusk.	Catfish.
(1) No.	8	237	1,154	401	84	3	1	4	2	19
Av.	4·0	118·5	577·0	200·5	42·0	1·5	0·5	2·0	1·0	9·5
(2) No.	26	471	3,429	2,263	190	10	23	7	7	23
Av.	5·2	94·2	685·8	452·6	38·0	2·0	4·6	1·4	1·4	4·6

All, it will be noticed, were relatively more numerous in the deeper water hauls, except codlings, gurnards, ling, and cat-fish; whitings were more than twice as abundant, and hake still better represented. Gurnards

were taken in the deepest haul, in seventy-eight fathoms, twenty-six being taken there. The number of anglers obtained in the deeper water was nineteen, or an average of 3·8 per haul; in the two drags in shallower water only one was caught. Twenty-five starry rays were taken in fifty and sixty fathoms, an average per haul of 12·5; eighty were caught in from seventy-one to seventy-eight fathoms, the average being 16.

The records of these hauls do not, however, give a proper idea of the proportional abundance of the various species of fish present on the grounds, because the smaller forms escape through the meshes of the ordinary otter-trawl. Experiments on a former occasion with small-meshed nets showed that the Norway pout (*Gadus Esmarkii*) exists in great numbers, as well as long rough dabs of all sizes. A coal-fish taken in the fifth haul, in seventy-one fathoms, was found to have in its stomach two argentines and two Norway pouts.

I append the records of the temperature observations:—

Date.	Depth.	Approximate Position.	Air.	Surface.	Bottom.
1902.	Fms.				
23 May	67½	About 80 miles S.S.E. of Sumburgh Head	45·7	44·0	42·8
24 ,,	71	About 50 miles E. by S. of Sumburgh Head	52·0	45·1	43·3
26 ,,	60	About 50-60 miles E.S.E. of Bressay .	46·5	45·0	43·5
27 ,,	74	About 50-60 miles S.E. by E. of Sumburgh Head	46·0	44·6	42·9
28 ,,	70	Do. do. do. .	46·4	45·0	43·8

3. The Great Fisher Bank and North-Eastern Grounds in June.

A voyage to the eastern side of the North Sea was made at the end of May on board the steam-trawler "Caledonia I.," the recorder in this instance being also Mr. William Mason. The vessel left Aberdeen on the morning of May 30th, steering a course E. by S. from Girdleness, and steaming a distance of 170 miles to the Great Fisher Bank. The first haul was made the next morning, the depth being thirty-four fathoms and the bottom sandy. There was a moderate easterly breeze and the sea was choppy; the temperature of the surface water was 48·2°F., and of the bottom water 43·2°F. The drag lasted four hours and the catch was small, the fishes numbering 432, of which 326 were marketable and 106 unmarketable, the latter consisting chiefly of small haddocks and whitings. Included among the marketable fishes were 230 haddocks—only forty-three, or about half a basket, being "firsts"—thirty-seven whitings, five cat-fish, seven gurnards, one halibut, forty plaice, and one grey skate.

The second haul, in the same depth, was hardly more productive, 445 fishes being obtained, 327 of which were marketable and 118 unmarketable, the latter again consisting for the most part of small haddocks and whitings. Five cod were included in the marketable catch, 213 haddocks, twenty-five whitings, five cat-fish, one ling, one small halibut, and seventy-three plaice. Two other trawlers were observed working in the immediate neighbourhood.

Ten other hauls were made on this ground, each for four hours, but the fishing continued unproductive. The largest number of fish caught in any of the hauls completely recorded was 642, of which 371 were marketable, and the smallest number in any haul was 235, of which 204

were marketable. The number of marketable haddocks ranged from 311 down to ninety-four, and although the proportion of the larger classes was greater than on the north-eastern grounds in the previous week, the number taken—from one to three baskets—was too small to make any important addition to the profits of the catch. Whitings, never an important item from the financial point of view, were also poorly represented. Cod were present in fair proportion, being represented in most of the hauls, the number ranging from one or two to nineteen. Very few codling or gurnards were obtained in any of the hauls, but in most of the hauls cat-fishes were secured, the number varying from one to six. There were also a few of the "long" fishes, more abundant in the deeper water, viz. two ling and five saithe or coal-fish, but no hake or tusk were caught here. Six halibut were also taken, all being small.

Among the other flat-fishes, plaice were best represented—and indeed the Great Fisher Bank is frequented for the sake of this fish as well as for the haddock. They were taken in each haul, the number varying from eight to ninety-one, 519 altogether being secured in the nine hauls recorded, and they were all marketable, *i.e.* no small plaice were found. Common dabs were much scarcer; they were taken in six of the hauls, the numbers varying from two to seven, and the aggregate was twenty-six. Lemon soles were also scarce, the total being only twelve; one or two were taken in seven drags. No megrims were found, but twenty-six long rough dabs, in six of the hauls, the number ranging from two to eight, and likewise four witches, one in each of four hauls. No brill or turbot were caught. Skates and rays were represented by one grey skate and twenty-two starry rays, from two to eleven being caught in four of the drags. Anglers also, in harmony with the paucity of fish, were scarce, only five being taken altogether.

The aggregate number of fishes taken in the nine hauls completely recorded, representing thirty-six hours of actual fishing, was only 4096, or an average of 455·1 per haul, or 113·8 per hour. The average number of marketable fishes taken per haul was only 317·2, the unmarketable averaging 137·9. The condition of this part of the Great Fisher Bank at this time was therefore the reverse of prolific, and contrasts strongly with the inshore grounds and those in the north-east, even at the least productive period. The fish from the Fisher Bank, however, are much esteemed, and command good prices on the market, and the grounds were vigorously trawled over for a number of years; five or six years ago they were among the favourite places for Aberdeen trawlers.

The aggregate number and averages of the different kinds of fish obtained in the nine fully recorded drags on the Fisher Bank are as follows:—

	Flat Fish.					
	Plaice.	Lemon Sole.	Witch.	Common Dab.	Long Rough Dab.	Halibut.
No. . .	519	12	4	26	26	6
Av. per haul,	57·7	1·3	0·4	2·9	2·9	0·7
Av. per hour,	14·4	0·3	0·1	0·7	0·7	0·2

	Round Fish.							
	Cod.	Codling.	Had-dock.	Whiting.	Gur-nard.	Saithe.	Ling.	Cat-fish.
No. . .	52	79	2,837	423	50	5	2	27
Av. per haul,	5·8	8·8	315·2	47·0	5·6	0·6	0·2	3·0
Av. per hour,	1·4	2·2	78·8	11·7	1·4	0·1	0·05	0·7

When compared with the similar figures referring to the fishing in the previous week in the deeper water off the Shetlands, it will be seen that the corresponding averages for halibut and lemon soles were the same—the numbers, however, being very small,—and that in all other cases the averages for flat-fishes were less on the Fisher Bank, with the exception of plaice. In the case of the latter the difference was great, viz. 0·1 and 14·4—*i.e.*, plaice were one hundred and forty-four times more numerous on the Fisher Bank. The difference in the case of witches was also marked in the contrary way, the average per hour's fishing on the Fisher Bank being 0·1, and off the Shetlands 25·1, this fish being 125 times more abundant on the latter grounds. As already stated, no megrims were caught on the Fisher Bank, while the average on the north-eastern grounds was 4·9 per hour.

Among round-fishes the average was greater in the deeper water for all species except adult cod; for cod it was only 0·9 per hour's fishing as compared with 1·4 on the Fisher Bank—not a great difference. The difference in the averages for codling was much more marked, viz. 19·7 off the Shetlands and 2·2 on the Fisher Bank. The relatively large proportion of codling in the deeper waters is referred to elsewhere. Haddocks were more than twice as abundant on the deeper grounds, whitings five times, and gurnards four times more numerous. Cat-fish, on the other hand, were almost in equal proportions in the two regions.

After two days' trial of the Fisher Bank the unproductive nature of the catches necessitated a change of ground, and the vessel steamed about forty-five miles in the direction of N.W. by W. While work was being carried on on the Fisher Bank the wind had been blowing a moderate breeze from the east and north-east, and latterly strongly from the east, and the position of the vessel at the end was more westerly than when operations were begun, the last drag being made in thirty-seven fathoms.

The first haul was made on the evening of 2nd June, on the edge of the deeper water, in sixty fathoms, on a fine sandy bottom, approximately about ninety miles east from Buchan Ness. The catch was not completely recorded, but it included twelve cod, a basket of haddocks, one-and-a-half basket of witches, and two specimens of the Great Silver Smelt (*Argentina silus*). The next haul was made for four hours a little farther on, in eighty fathoms, the catch consisting of 466 fishes, of which 429 were marketable. It included fifteen cod, fifty-two codling, 164 haddocks, thirty-five whitings, five coal-fish, a ling, a tusk, four megrims, and 156 witches. The next haul was made in the same locality in eighty-one fathoms, and was somewhat better, the fishes taken numbering 690, of which 628 were marketable. It comprised five cod, 142 codlings, 229 haddocks, seventeen whitings, six coal-fish, two ling, one tusk, 253 witches, twenty-three long rough dabs, and one grey skate.

Five Norway haddocks were also caught in this drag. Two other trawlers were working on the same grounds.

The fourth haul, in seventy-nine fathoms, yielded 973 fish, of which 805 were marketable, the catch including eleven cod, 122 codling, 292 haddocks, 307 whitings, three coal-fish, four ling, three tusks, and 155 witches. A bib (*Gadus luscus*) was also taken. One haddock among those taken in this drag, on 3rd June, was spawning, illustrating the fact that the spawning season is later on the deeper northern grounds than farther south, although the bottom water, judging from the few observations made, was only half a degree colder than at the Fisher Bank, where none of the haddocks were observed to be in spawn—and the condition of the haddocks in this respect was made a special point of enquiry. The surface temperature at the Fisher Bank was about 2·5° F. warmer than in this locality.

The fifth haul was made in the same place, in eighty-one fathoms—the deepest of the series—and on a muddy bottom. The total catch was 831 fishes, of which 762 were marketable and 69 unmarketable. It comprised 12 cod, 100 codlings, 281 haddocks, 46 whitings, two saithe, one ling, three tusk, 335 witches, 18 megrims, and a grey skate, as well as three Norway haddocks.

Other six hauls were made in this neighbourhood, and the particulars of the seven hauls which were completely recorded are as follows, the depths ranging from seventy-six to eighty-one fathoms. The aggregate number of fishes caught was 5244, or an average per four hours' haul of 749·1, the average per hour's fishing being 187·3. The marketable fishes numbered 4571, with averages respectively of 653 per haul and 163·2 per hour. The unmarketable fishes numbered 673, the respective averages being 96·1 and 24. The particulars for the various species are given in the following Table:—

Flat Fish.							
	Plaice.	Lemon Sole.	Witch.	Common Dab.	Long Rough Dab.	Megrim.	Halibut.
No. . .	.	1	1,574	2	413	146	1
Av. per haul,	.	0·16	224·8	·3	59·2	20·8	0·16
Av. per hour,	.	0·04	56·2	0·07	14·8	5·2	0·04

Round Fish.									
	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Saithe.	Ling.	Tusk.	Catfish.
No. . .	69	571	1,794	513	36	37	18	10	1
Av. per haul,	10·0	81·2	256·4	73·2	5·2	5·2	2·4	1·6	0·16
Av. per hour,	2·5	20·3	64·1	18·3	1·3	1·3	0·6	0·4	0·04

The single specimens of the lemon sole and the halibut were got in the same haul in seventy-six fathoms, and the two common dabs in a haul in seventy-nine fathoms. Long rough dabs were present in each haul

in numbers varying from twenty-three to 167. The solitary cat-fish was obtained in seventy-six fathoms. Codlings were got in six of the hauls in numbers varying from one to 142, saithe in each haul, the highest number in a single drag being nine; ling were taken in six hauls, in numbers varying from one to five; tusk in four hauls, the highest number in any haul being three. Gurnards were represented in six of the hauls, the depths where they were taken running from seventy-six to eighty-one fathoms, and the largest number in a haul being fourteen.

Two grey skates were obtained in eighty-one fathoms, and one starry ray in seventy-six fathoms. Thirty-five anglers were taken, the average per haul being five; the largest number in a haul was eight. Ten specimens of the Norway haddock (*Sebastes*) were secured in three hauls in seventy-six and eighty-one fathoms; four specimens of the bib in seventy-six, seventy-nine, and eighty fathoms; two Norway pouts in seventy-six fathoms, a *Lumpenus* at the same depth, and three argentines in eighty fathoms.

Other five hauls were made in the same neighbourhood, but in somewhat shallower water, viz. from sixty-four to seventy-one fathoms. The bottom was muddy, and the duration of the hauls the same as before—namely, four hours. Complete records were made of the catches of four of the drags. The aggregate number of fish taken was 2635, the average per haul being 658·7, and per hour's fishing 164·7. The marketable fishes numbered 2237, and the unmarketable 398. The particulars regarding the numbers and averages of the various species taken are as follows:—

Flat Fish.						
	Plaice.	Lemon Sole.	Witch.	Common Dab.	Long Rough Dab.	Megrim.
No. . .	.	.	462	.	193	40
Av. per haul,	.	.	115·6	.	48·4	10·0
Av. per hour,	.	.	28·9	.	12·1	2·5

Round Fish.									
	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Saithe	Hake.	Ling.	Catfish.
No. . .	50	83	1,567	124	22	65	2	4	2
Av. per haul,	12·4	20·8	392·0	31·2	5·6	16·4	0·4	0·8	0·4
Av. per hour,	3·1	5·2	98·0	7·8	1·4	4·1	0·1	0·2	0·1

Among the flat-fishes the principal change is a reduction in the averages for those species represented—witches, megrims, and long rough dabs. The average for cod is a little higher, those for codlings and whiting reduced; ling and haddocks are also less, and saithe increased, while hake is now for the first time represented by two

specimens. There were also taken in these hauls two grey skates, two starry rays, and seven anglers, as well as four argentines, two Norway pouts, two bibs, a herring, and a mackerel. The two latter may have been taken when the net was being shot or hauled, but I have previously found herrings in the stomachs of anglers caught in from 62-65 fathoms about sixty-five miles S.E. by E. of Sumburgh Head.*

The vessel left the fishing ground for port on the morning of 5th June, and steamed seventy-four miles W.S.W.

The temperature records are as follows :—

Date.	Depth.	Approximate Position.	Air.	Surface.	Bottom.
1902.	Fms.				
31 May	34	Fisher Bank, 170 miles E. by S. from Girdleness	50·5	48·2	43·2
1 June	34	Fisher Bank, 160 miles E. by S. from Girdleness	52·3	48·9	43·8
2 ,,	34	Fisher Bank, 150 miles E. by S. from Girdleness	49·6	48·4	43·2
3 June	79	80-90 miles E. from Buchan Ness .	50·9	46	42·9
4 ,,	76	80 ,, ,, ,, .	51·0	46	42·8
4 ,,	71	70 ,, ,, ,, .	49·3	46·3	43·2
5 ,,	66	60 ,, ,, ,, .	50·2	47·0	43·2

4. The Moray Firth and Aberdeen Bay in October.

In October another series of trawling experiments was conducted in Aberdeen Bay and the Moray Firth, the trawler used being the "Star of the Sea," part of the hauls being recorded by Dr. H. C. Williamson. The expedition had more than usual interest from the circumstance that the vessel was equipped with a full-sized beam-trawl (50 ft. 6 in.) on one side and an otter-trawl on the other, the intention being to make a series of experiments on the same grounds by using the nets alternately with the object of determining the comparative efficiency of each kind of gear. As a practical appliance the beam-trawl is now quite obsolete on steam-trawlers; but for the purpose of bringing certain statistics of previous years, when it was exclusively employed, into relation with the statistics obtained after the otter-net was introduced—a matter of much importance—it is necessary to have a series of comparative hauls from the same grounds at the same time. Unfortunately in this case the beam-trawl was lost in the second trial. It is possible the beam itself, which was one discarded when the new net came into vogue, was not as strong as if it had been new; but the difficulty of adapting the gear for otter-trawling to the beam-trawl may have had something to do with the mishap.

The first haul made was with the beam-trawl in Aberdeen Bay on 2nd October, off the "Black Dog." The net was shot in twenty fathoms and towed into shallow water, even into four fathoms, and after fishing in a depth from that named upwards it was lifted in eighteen fathoms. The haul lasted for five hours and twenty minutes, and the marketable catch was a poor one, consisting of one cod, three baskets of small haddocks, a basket of dabs, and a little over half a basket of plaice. The

* *Nineteenth Ann. Rep., Part III.*, p. 288.

numbers of the fish were as follows, the marketable being represented on the first line (I.) and the unmarketable on the second line (II.):—

	Plaice.	Com. Dab.	Turbot.	Long Rough Dab.	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Starry Ray.	Thornback.	Total.
I.	52	93	1	.	1	12	668	60	.	.	.	887
II.	47	379	.	33	.	.	101	15	32	7	9	623
	99	472	1	33	1	12	769	75	32	7	9	1,510

The plaice consisted of nineteen large, eight medium, and twenty-five small but marketable, and forty-seven too small to be marketable, due to the fishing in the very shallow water. There were only three large haddocks, and 665 small but marketable, besides 101 too small to be marketable.

The second haul was made in the same place, the net being shot in seventeen fathoms and worked into six and ten and fifteen fathoms, and it lasted five hours and fifteen minutes, or five minutes less than the previous haul. The marketable catch in this instance consisted of ten-and-a-half baskets of haddocks, four-and-a-half baskets of plaice, one-and-a-quarter basket of whitings, one of dabs, and a quarter of a basket of codlings, as well as eight cod. It was thus very much larger. All the fish were enumerated, except the codlings. The number, excluding the codlings, was 3300, of which 2968 were marketable and 332 unmarketable. Allowing twenty codlings for the quarter-basket, the total of marketable would be increased to 2988 fishes.

The details are as follows:—

	Plaice.	Lemon Sole.	Common Dab.	Long Rough Dab.	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Starry Ray.	Thornback.	Angler.	Total.
I.	310	5	168	.	8	[20 ?]	2,316	161	.	.	.	.	2,968
II.	62	2	162	31	.	.	37	9	3	13	6	7	332
	372	7	330	31	8	[20 ?]	2,353	170	3	13	6	7	3,300

All the fishes, except the long rough dabs and the gurnards, were in greater numbers than in the preceding haul with the beam-trawl.

Little can be deduced from a single drag with each net as in this experiment, but as it is, so far as I am aware, the only one of the kind yet made, it may be worth while to discuss the results. The number of flat-fishes taken with the beam-trawl was 605, or 40·0 per cent. of the total catch; with the otter-net the number was 740, or an excess of 135, but the percentage was only about half, viz. 22·4 per cent. If the skates and rays be included—and they are equally characteristic bottom fishes—the number in the case of the beam-trawl becomes 621 and the percentage 41·1, and in the case of the otter-trawl the number is 759 and the percentage 23. The deduction from these figures, considered alone, is that the otter-net is more efficient than the beam-trawl in catching flat-fishes in the proportion of 1·22 to 1, or 22 per cent.—in other words, that the spread of the net in fishing is that percentage

greater than the width of the beam-trawl. Since the width of the mouth of the beam-trawl is constant and known, viz. fifty feet six inches, the width of the mouth of the otter-net at the ground would then be about sixty-one feet six inches. In this instance the length of the head-line between the otter-boards was 140 feet, and, on the supposition above stated, the arc of the line in fishing would absorb over 78 feet, the proportion of the distance between the boards to the length of the head-line connecting them being as 1 to 2·2. This is not very greatly different from the results of the experiments with the small nets of the "Garland" last year,* where the ratio of breadth to length of head-line was found to be as 1 to 1·9, and the calculated width of the mouth of a large otter-net with a head-line of 130 feet was placed at 68½ feet.

No certain conclusion as to the precise fishing-width can, however, be based upon a single experiment, but the result, so far as it goes, supports the opinion I previously expressed, that the spread of the otter-trawl on the ground is much less than is usually supposed. It will be noticed, moreover, in the above experiment that the proportion of the various species of flat-fishes varied considerably in the two cases, plaice giving the majority in the catch of the otter-trawl and dabs in the catch of the beam-trawl. The circumstance shows that the ground worked over in the two drags was not quite the same; the slight excess of long rough dabs in the catch of the beam-trawl probably indicates that it was conducted on the whole in somewhat deeper water.

The difference in the catch of the round-fishes in the two cases is very marked. The beam-trawl caught 889 and the otter-trawl 2534, or, allowing twenty codlings for the quarter-basket, 2554. The proportion was thus 1 to nearly 2·9, as compared with 1 and 1·22 in the case of the flat-fishes. The greatest proportional increase was in cod—but the numbers were quite small,—and next in haddocks, which formed the great bulk of the catch. The result agrees with the conclusion previously reached,† that the arc of the head-line in fishing is not horizontal, but rises high in the water, and thus takes many of the active round-fishes that were above, or got above, the beam of the beam-trawl.

The third haul in Aberdeen Bay was with the otter-net, in from ten to eighteen fathoms, off Collieston, and the catch was a heavy one, consisting for the most part of 23½ baskets of haddocks—all but half a basketful being small or "thirds,"—four baskets of whitings, 3¼ of codlings, three of plaice, and half a basket of dabs, as well as five cod, three turbot, and two black soles. The latter is a very rare fish on the east coast of Scotland, but one or two are occasionally taken while trawling in the bays and firths.

The number of fishes caught in the three hours and twenty minutes during which the drag lasted was 7023, perhaps the largest in the records, owing almost entirely to the quantity of small haddocks, which were extremely abundant last autumn over almost the whole of the North Sea. Of the total, 6732 were marketable and 291 unmarketable. The codling taken were also exceptionally numerous, viz. 623, of which 578 were marketable. The haddocks numbered 5098, all but eighteen marketable, but there were only thirty-two large ones, or "firsts," and fifty-two mediums, or "seconds," the small or "thirds" numbering 4996. Whitings were numerous—772, of which 690 were marketable. The details of the catch are as follows, I. representing the marketable and II. the unmarketable fishes:—

* *Twentieth Ann. Rep., Part III.*, p. 122.
† *Loc. cit.*

	Cod.	Cod-ling.	Had-dock.	Whit-ing.	Tur-bot.	Black Sole.	Plaice.	Lemon Sole.	Com. Dab.	Thorn back.	Starry Ray.	Total.
I.	5	578	5,080	690	3	2	132	2	240	.	.	6,732
II.	.	45	18	82	.	.	11	2	124	2	7	291
	5	623	5,098	772	3	2	143	4	364	2	7	7,023

The next haul was made on 4th October in the Moray Firth, at Burghead Bay, in from nine to fourteen fathoms, and it lasted for four hours and ten minutes. Only the marketable fishes were enumerated, and of these 2473 were taken, consisting mostly of small haddocks and small plaice. The catch included two cod, ninety-two codlings, and 1083 haddocks, of which only seventy-two were large or "firsts," all the others being small. Whitings numbered 150, and gurnards, 228—this part of the coast being usually very rich in gurnards—while one hake and one ling were also taken, as well as a mackerel. Among the flat-fishes plaice numbered 730, of which 458 were very small; there were also twenty-seven common dabs (marketable), 122 witches, and twenty-one lemon soles. The unmarketable fishes, consisting mostly of dabs, haddocks, and gurnards, filled fourteen baskets.

The next haul was made in the same place, in from five to twenty fathoms of water, but mostly in from seven to nine and a half, for four hours and forty minutes, and the marketable catch consisted of 3598 fishes, haddocks and plaice again forming the greater proportion. The haddocks numbered 2225, but they were, with the exception of sixty, all small; the fourth selection of very small marketable fishes numbered 857, and the "thirds" 1308. There were 696 marketable plaice, of which 407 were "thirds," and 114 "fourths," or the smallest marketable. The marketable common dabs numbered 409, and four witches, thirteen lemon soles, and one black sole were included. The unmarketable fishes, mostly dabs, filled twelve baskets.

The third haul in the Moray Firth, on the same ground, in from five to nine fathoms, lasted for four hours and twenty minutes, and the catch was a large one. The marketable fishes, which were alone enumerated, numbered 4786, comprising 2014 haddocks, 2139 plaice—of which 1354 were "fourths" and 536 "thirds"—482 common dabs, thirty lemon soles, seventy gurnards, three brill, and six thornbacks, as well as two saithe and forty codlings. The aggregate number of fishes taken must have been very large, because those that were unmarketable, mostly dabs and gurnards, filled fifteen baskets.

The catch of the fourth drag, in the same place, in four to eight fathoms, and lasting five hours, was completely enumerated. The fishes numbered 4532, of which 2397 were marketable, and 2135 unmarketable. There were twenty-five unmarketable codling, 290 haddocks—the reduction in the numbers in this fish being no doubt owing to the shallower water in which the drag was made—of which twelve were unmarketable, seven whitings, 174 gurnards, and 2131 plaice, of which 827 were medium, 174 large, 548 small, 160 "fourths," and 425 unmarketable. Common dabs numbered 1885, all being unmarketable except 245, and there were also one ling, three small lemon soles, fourteen thornbacks, and two sand-eels, as well as 240 squids.

Other five hauls were made in Burghead Bay, in from five to twenty, and mostly in from six to thirteen or fourteen fathoms, the

highest catch of marketable fishes being 2404, chiefly haddocks and plaice.

The marketable fishes obtained in the nine drags are as follows, with the average per hour's fishing :—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Saithe.	Hake.	Ling.
(1) No.	5	287	9,227	160	884	2	2	2
Av.	0·1	8·0	252·8	4·4	24·2	0·03	0·03	0·03

	Plaice.	Brill.	Common Dab.	Lemon Sole.	Witch.	Thornback.
(2) No.	7,903	27	1,558	72	226	54
Av.	216·5	0·8	42·7	2·0	6·2	1·4

The aggregate number taken, including a mackerel and a grey skate, was 20,412, or an average per hour's fishing of 559·2, a very considerable proportion. The bulk of the catch consisted of plaice and haddocks, but if the unmarketable fishes had been included, it is probable that the first place, so far as numbers are concerned, would have been taken by the common dab. Particulars were kept of the selections made on board of the haddocks and plaice according to their sizes, and the particulars are of interest. Both were divided into four classes, firsts or large, seconds or medium, and thirds or small, and fourths or extra small, a division which has come into vogue owing to the rise in the price of fish. The fourth class, and perhaps the smaller of the third, were previously not brought to market. The numbers of each are as follows:—

	Plaice.	Haddock.
1st, - - - -	458	168
2nd, - - - -	2,089	60
3rd, - - - -	2,847	8,142
4th, - - - -	2,509	857
	7,903	9,227

Thus sixty-seven per cent. of the plaice and ninety-seven per cent. of the haddocks were small. Medium haddocks were especially scarce and less abundant than the large ones. Whitings were remarkably few in numbers, only 160 having been procured of marketable size in the nine hauls, while gurnards, on the other hand, as compared with Aberdeen Bay and the inshore places on the northern side of the Firth, were abundant.

The catches, as will be observed from the Tables, began to diminish in productiveness after the third haul. The first three drags yielded 10,855 marketable fishes in thirteen hours and ten minutes' trawling; the next three drags yielded 6835 marketable fishes in thirteen hours and thirty minutes' trawling. The eighth haul produced only 937, and the ninth 1131, marketable fishes. This reduction in the numbers might be regarded as an instance of the temporary clearing away of the bottom fishes on a limited ground by the repeated action of the trawl; and to some extent this may be the case, for the total of 20,412 is a

large one for thirty-six and a half hours' work. But in the last drag the net was found to contain a very large number of dog-fishes, showing that the ground had been invaded by these predaceous forms, and in such a case it is usual for the other fishes to move away.

The occurrence of dog-fishes in this region, where they have not uncommonly been taken, and the frequent presence of various other species characteristic of deeper water, as ling, hake, *Lumpenus*, the Norway pout, &c., is probably explained by the extension along the southern coast of the Moray Firth of a channel or gut of deeper water, an offshoot from the North Sea, along which the fishes referred to make their way.

The next haul of the trawl was made in the Dornoch Firth, off Dunrobin, on the night of 6th October, in from eight to thirteen fathoms. As a result of the four-and-a-half hours' drag only 405 marketable fishes were secured, including thirty-six haddocks, thirty gurnards, 295 plaice, thirty-four common dabs, and six thornbacks.

The second haul on this ground was more productive; it was made in from five to twelve fathoms, and lasted for four hours and a quarter. The aggregate number of fishes taken was 2282, of which 1544 were marketable and 738 unmarketable. Haddocks were again scantily represented, totalling thirty-four, of which eight were too small to be marketable, the other twenty-six being all large. This is not uncommonly the case in the Dornoch Firth, where some of the largest haddocks I have seen were taken. These old and large fish, occasionally very thin and infested with ectoparasites, and rarely fat, are probably sluggish and less able to escape their foes than when smaller, and make their way into the shallow bays, where they are much more secure from the attacks of the larger predaceous forms. The plaice taken numbered 1519, all but ninety-seven of marketable size. The large class was represented by fifteen individuals, the medium by 202, the small by 480, and the very small by 725. Among the other flat-fishes were four brill, five lemon soles, and 618 common dabs, of which twenty were marketable. There were also eighty-nine gurnards, seven thornbacks and six anglers, and twenty-five squids.

The next drag was also productive, yielding 1957 fishes, 1605 being marketable. The catch included fourteen cod, ninety codling, 170 marketable haddocks—of which 115 were large, twenty medium, and thirty-five small,—eleven whitings, and sixty-six gurnards. Among the 1335 plaice taken, 1218 were marketable, the large class comprising fifty-three, the mediums 158, the small class 358, and the very small 649. There were also three brill, nineteen lemon soles, and 228 common dabs.

Other six hauls were made in the Dornoch Firth, the total catch varying from 3814 to 506; in the latter instance, however, the net caught on the bottom and got torn after being down forty-five minutes. The largest catch included eighteen baskets of haddocks, mostly large, nine of plaice, one-and-a-quarter of codlings, and one of gurnards, as well as eight cod, two brill, five lemon soles, eighty common dabs, and six thornbacks.

The aggregate number of fishes obtained in the eight hauls which were completely enumerated, and which comprised thirty-one-and-a-half hours' actual fishing, was 18,084, of which 12,284 were marketable and 5800 unmarketable, the average numbers per hour's fishing being respectively 574·1, 390, and 184·1. It was considerably less, therefore, than at Burghead Bay. The particulars are as follows, I. representing the marketable and II. the unmarketable fishes:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Plaice.	Lemon Sole.	Common Dab.	Brill.	Thornback.	Angler.	Total.
I.	25	311	2,382	16	555	8,591	42	299	23	40	.	12,284
II.	.	39	42	12	127	1,086	2	4,473	.	.	19	5,800
	25	350	2,424	28	682	9,677	44	4,772	23	40	19	18,084
Av. per hour,	0·8	11·1	76·9	0·9	21·6	310·4	1·4	151·5	0·7	1·4	0·6	574·1

It will be seen that plaice occupied first position with a total of 9677, of which 8591 were marketable; dabs followed with 4772, comparatively few being marketable, the third place being occupied by haddocks with a total of 2424, all save forty-two being marketable. Whitings were very poorly represented, the total being only twenty-eight, but gurnards were abundant, and the number of brill was considerable, viz. twenty-three. It may be of interest to compare the average catch of the marketable fish per hour's fishing with the corresponding averages for Burghead Bay on the south coast, and I place them here in conjunction:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Thornback.	Plaice.	Lemon Sole.	Common Dab.	Brill.	Witch.
Burghead Bay, .	0·1	8·0	252·8	4·4	24·2	1·4	216·5	2·0	42·7	0·8	6·2
Dornoch Firth, .	0·8	9 9	75·6	0·5	17·6	1·4	272·7	1·3	9·5	0·7	.

In the case of gurnards and common dabs the comparison of the marketable fishes alone may not accurately represent the true proportions caught, because the selection of these cheap varieties may differ.

The proportions of the various selections of the plaice and haddocks taken in the Dornoch Firth in the hauls in question are these:—

	Plaice.	Haddock.
1st, - - - -	262	1,630
2nd, - - - -	1,398	234
3rd, - - - -	2,424	518
4th, - - - -	4,507	—
	8,591	2,382

If compared with the similar figures for Burghead Bay (p. 34), the great difference in the proportion of large and small haddocks in the two places is apparent. In the former locality the percentage of small plaice was sixty-seven, while in the Dornoch it was 80·7; the percentage of small haddocks at Burghead Bay was ninety-seven, and at the Dornoch it was 24·3.

The results in the Dornoch Firth did not show any diminution of the catches in the later hauls such as was exhibited at Burghead Bay. On the contrary, the later hauls were rather more productive than the earlier ones. Thus the first three, which lasted altogether for thirteen

hours and a half, yielded 7038 fishes, of which 5002 were marketable, while the last three hauls, which lasted for thirteen hours, produced 8790 fishes, of which 5946, or nearly a thousand more, were marketable. With regard to flat-fishes, the aggregate number of plaice in the first three hauls was 4170, and in the last three 4164; the number of dabs in the first three hauls was 1539, and in the last three 2432.

The vessel left the Dornoch Firth on the morning of 9th October, the next drag being made for four hours and forty minutes, just outside of Tarbet Ness, in from nine to twenty fathoms. The catch consisted of 1971 fishes, the marketable numbering 1488, and the unmarketable 483. Included in the total were 106 codlings, 100 haddocks, none of which were small, and 118 gurnards, mostly large. The plaice numbered 1245, of which 1153 were marketable, 615 belonging to the fourth class, 366 to the third, 119 to the second, and 53 to the first. The number of common dabs was 390, and there were also three brill, four lemon soles, and five thornbacks.

The next haul was made a little farther out, in from nineteen to twenty-five fathoms, Tarbet Ness bearing W.S.W., and it lasted for three hours and twenty minutes. The fishes taken numbered only 629, of which 452 were marketable. Included amongst them were three cod, twenty codlings, 146 haddocks—sixty-seven large, thirty medium, and forty small,—ten whitings, two ling, and fifty gurnards. The flat-fishes comprised 242 plaice, of which 219 were marketable, viz. twenty-four large, seventy-four medium, twenty small, and 110 very small, and twenty-three too small to be marketable. There were also fourteen lemon soles, all marketable, 139 small common dabs, and three thornbacks.

The vessel then steamed to Aberdeen Bay, where three drags were made on 10th October. The first, in from five to twelve fathoms, off Newburgh, lasted for four hours and a quarter. The catch was not enumerated, but it was considerable, consisting of twenty-one baskets of small haddocks and three-quarters of a basket of large, and seven baskets of plaice, three containing mediums, two small, and two extra small. There were also a basket of common dabs, a brill, a codling, and twenty whitings. The unmarketable fishes filled three baskets, so that the aggregate quantity was about thirty-three baskets.

In the third haul, which lasted for five hours, in from five to ten fathoms, 2574 marketable fishes were taken, viz. 1572 haddocks, all except fourteen large belonging to the third class, 817 plaice, of which twelve were large, 372 medium, 223 small, and 210 very small, two brill, 160 common dabs, and twenty-three gurnards.

The fishes taken in the second haul were enumerated, the haul lasting for five hours and ten minutes, in from four to twelve fathoms. The total number was 3003, of which 2619 were marketable and 384 unmarketable. The haddocks numbered 1555, and comprised ten large, no mediums, and 1522 small, besides twenty-three too small to be saleable. There were 948 plaice, 839 being marketable, viz. 228 mediums, 341 small, and 270 very small; there were also 109 unmarketable. Besides these were thirteen codling, nine whiting, thirty gurnards, three brill, and 445 common dabs.

II. Special Statistics of North Sea Fisheries.

In last annual Report* I discussed in some detail the statistics relating to the North Sea fisheries, particularly in connection with trawling, and formulated a scheme of statistics with the special object

* *Twentieth Ann. Rep., Part III.*, "North Sea Investigations," p. 74 *et seq.*, p. 135.

of ascertaining in a definite way the productiveness of the fishing grounds in successive years. The principal points emphasised were the necessity of dealing with the catches of the individual vessels, those using different methods of fishing being kept separate and distinct, and the obtaining of particulars as to the precise locality where the fish were caught. I also furnished tables, illustrated by charts, giving these particulars for a large number of trawlers fishing throughout the year 1902, and during part of the year 1891. This system, which I described before the Committee on Ichthyological Research in October 1901,* and was commended by them, was also approved by Continental experts, and has been continued since.

It has, however, been deemed desirable that the detailed information thus acquired, which also throws much light on the distribution and migration of the food fishes on the different grounds, as indicated in the following pages, should be reserved for the use of the International Committee now engaged in fishery research in the North Sea, and I propose here only to indicate a few of the points of contrast between the returns for 1901 and those for 1902.

The great variation in the relative abundance or distribution of the various food fishes on the grounds in the different parts of the North Sea is again revealed, more particularly when the deep-water areas to the south, south-east, and east of the Shetlands are contrasted with the more southern and eastern areas, where the water is not so deep. As I pointed out last year, this fact may exercise a very considerable influence on the statistics of the fish landed according to the areas which are chiefly frequented by the fishing vessels in any particular year. The circumstance adverted to † that trawlers last year had resumed operations in greater force on the Fisher Bank than for some time past, and that this change in the locality of fishing would particularly affect the catches of flat-fishes, especially plaice, witches, and megrims, has been borne out by the facts. The accompanying Table, which shows the number of landings from the various square-areas (as numbered in the charts referred to) in each month of the year, so far as the particulars were ascertained, indicates how greatly the area of fishing was shifted. Squares XXV. and XXXI. represent the grounds known locally as the Fisher Bank, and it will be seen that while only 34 landings from these two areas were registered in 1901, there were no less than 173 in 1902. On the other hand, the proportion in most of the areas to the south, east, and south-east of the Shetlands was less, viz., XI., XIV., XVIII., and XIX. Thus, in the cases recorded, the quantity of plaice landed from the two areas in question on the Fisher Bank was $128\frac{1}{4}$ cwts. in 1901, while last year the quantity was $764\frac{1}{4}$ cwts.; the aggregate from all the trawlers fishing there (only part of whose catches are included) was of course much greater. The effect on the statistics of fish landed of this change will be readily understood from the Tables showing the percentage proportions of flat-fishes in different areas.

* *Report of the Committee on Ichthyological Research*, pp. viii., 1-8; 1901 [Cd. 1312].
† *Twentieth Ann. Rep., Part III.*, p. 86.

[TABLE.

No. of Square.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.
VI.	...	...	...	...	...	2	...	10	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
VII.	...	...	...	...	...	2	5	21	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14	23
VIII.	...	...	...	...	...	...	3	4	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	4	5
IX.	...	...	1	...	...	...	...	...	...	...	...	...	1	2	...	1	1	...	...	...	...	...	2	3	5	
X.	3	1	9	3	7	2	8	3	3	...	...	...	1	...	...	...	...	1	...	3	10	3	1	1	42	17
XI.	5	4	12	7	20	16	43	20	20	5	3	1	1	1	1	1	3	1	...	4	1	3	2	3	111	66
XII.	...	...	1	...	...	1	2	1	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...		4	3
XIII.	...	...	13	...	4	...	...	1	...	...	...	...	2	1	...	...	...	...	...	...	...	...	...	...	19	2
XIV.	13	3	38	18	32	5	6	1	4	3	14	...	12	...	6	2	5	6	12	15	14	11	10	6	166	70
XV.	10	13	36	19	10	7	5	1	17	7	12	3	3	...	2	3	2	10	3	34	13	19	12	18	125	134
XVI.	...	...	...	2	2	5	6	...	3	...	...	...	...	...	...	...	1	...	1	1	8	1	4	1	25	10
XVII.	3	...	19	4	11	1	10	4	15	1	8	...	8	1	2	2	...	...	...	3	2	3	...	2	78	21
XVIII.	14	29	39	13	27	31	11	4	4	...	19	...	12	8	19	4	12	3	14	1	8	3	19	7	198	103
XIX.	47	15	9	10	14	5	5	2	8	4	8	8	3	6	1	1	3	1	7	4	21	5	12	34	138	95
XX.	...	1	1	2	6	1	1	5	2	9	3	6	2	2	...	1	2	1	3	1	11	2	3	3	34	34
XXI.	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	1	...	3	1
XXIII.	109	58	42	33	29	13	52	12	32	17	2	6	15	8	21	16	12	22	43	44	26	31	39	54	422	314
XXIV.	...	...	1	2	25	2	1	2	...	2	...	2	8	1	3	9	2	3	18	4	4	16	1	17	63	60
XXV.	...	...	...	...	2	...	...	...	4	19	2	24	4	11	1	5	2	4	9	7	...	12	...	4	24	86
XXVI.	...	...	...	...	...	...	...	...	...	1	...	1	1	...	...	...	...	...	...	6	2	...	...	...	3	8
XXVIII.	5	...	8	1	7	1	...	...	3	...	1	...	3	1	3	...	1	...	1	1	1	...	2	...	35	4
XXIX.	...	...	4	...	5	1	13	14	15	9	29	31	37	43	43	35	28	14	25	18	21	30	2	12	222	207
XXX.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	4	...	3	4	...	4	1	13	9	23
XXXI.	...	...	...	...	...	...	...	...	5	4	...	3	...	27	1	19	...	17	3	6	1	9	...	2	10	87
XXXII.	...	...	...	...	...	...	...	...	3	1	4	...	10	...	5	1	5	1	5	4	...	4	...	...	32	11
XXXIII.	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	1	1
XXXIV.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	...	1	...	...	...	...	...	3	1
XXXV.	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	1	...	...	...	3
XXXVI.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...
XXXVII.	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
XXXVIII.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...
XLI.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...
XLV.	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...

III. The Distribution and Migrations of the Food Fishes.

The investigations on board trawlers have also furnished a considerable body of evidence with regard to the distribution of both young and adult fishes on the deep-water grounds and on those inshore. The experiments made by fixing on a small-meshed net around the cod-end of the otter-trawl, in order to capture the smaller fishes which escape through the meshes of the latter, give much important information as to the presence at the time on the ground when the haul was made of the very young forms of the food fishes, as described below. But the records of the marketable and unmarketable fishes taken with the ordinary net are likewise of importance, both in regard to the distribution of the fish and to the action of the trawl in capturing immature individuals. It will be found that the proportion of these taken differs largely with different species.

In most cases the classification of the fishes adopted by the trawler, into marketable and unmarketable, represents roughly the difference in the size, since the value of most of those taken depends upon the size. Thus, whether or not codling, whiting, haddocks, witches, &c., be taken to market or thrown overboard depends upon the size, for there is always a market for them. But the selection may be somewhat different at different times, or even by different men; for example, if prices rule high smaller fish than usual may be brought ashore; if prices are low it may be considered not worth while to take the smallest. Moreover, the selection in the case of some of the cheaper kinds, as gurnards and dabs, is very variable, and with some other forms usually considered inedible, as anglers, the larger only are made use of, and it may be not at all. The following sizes may be given as generally ruling whether the fish are marketable or unmarketable:—Codling 11½ inches, haddock 9–9½ inches, whiting 9–9½ inches, lemon sole 8–8½ inches, witch 9–10 inches, megrim 9–10 inches, brill and turbot 8–9 inches, cat-fish 14–15 inches, ling 15–16 inches, tusk 14–15 inches, hake 15 inches. These limits are derived from measurements on board the vessels, but the number of small forms obtained of the four last is small.

A study of the facts shows that the proportions of the marketable and unmarketable varies very considerably with different species, and furnishes evidence of the presence or absence of the younger fishes on the ground.

Plaice (*Pleuronectes platessa*).

The distribution of the young of this fish is well known, the very young stages, following the assumption of the adult form, being found at the margin of the beach or in shallow tidal estuaries as the Solway; and as they increase in size they move further out into somewhat deeper water. In the hauls made on board the steam-trawlers the proportion present varied very much according to the prevailing depth of water in which the drag was made. In the foregoing pages and in the Tables appended particulars are given showing this proportion in different cases. But if all plaice must begin their bottom-life quite at the margin of the sea, the cases where the larger plaice are taken is deep water at considerable distances from shore acquire some interest as showing the extent of the migration of this fish from its original habitat when young. I have tabulated the hauls with this object in view, and beginning with those nearest shore, and in least depths, I find that in the Moray Firth, from about two and a half to four miles from shore, in depths from eighteen to twenty-seven fathoms, sixteen or seventeen

hauls yielded 796 plaice, none of which were unmarketable. Farther off, on Smith Bank and near it, a number of hauls gave an aggregate of 417 plaice, none of which were unmarketable, the depths ranging from twenty-two to thirty-five fathoms. In twenty fathoms, off Tarbet Ness, twenty-six were taken in a haul, and none were small; in a haul in fifty fathoms twelve miles off the south shore three were got, all large; and about eight miles off Kinnaird Head, in 83–85 fathoms, none were taken in a haul.

In hauls extending into shallow water, as four, five, and six fathoms, a small proportion of unmarketable plaice may be obtained.

At the depression off Aberdeen, known locally as the Dog Hole, in depths from fifty-seven to seventy fathoms, and from eight to thirteen miles from land, six plaice were got in seven hauls—viz., three in two hauls in 57 fathoms, one in 58 fathoms, one in 65 fathoms, and one in 70 fathoms—and none were small or unmarketable.

In the hauls on the north-eastern grounds, several large plaice were taken in about fifteen hauls in sixty-five fathoms, sixty-five miles S.E. by E. of Sumburgh Head, Shetland, which was the nearest land. None were taken in 63 and 81 fathoms, about 87½ miles N.E. of Buchan Ness, or about fifty miles from Fair Isle and sixty-five miles from the Orkneys; but nearer Fair Isle, about eighteen to twenty-two miles to the south-east, in sixty-five and sixty-six fathoms, 193 plaice were taken in October in nineteen hauls—some being got in each, the numbers varying from one to twenty-six, and they were all large. The usual range of their size was about twenty inches. Several measured twenty-six and twenty-seven inches, and the four smallest were 43·4, 39·0, 39·8, and 37·5 centimetres—from seventeen to fourteen and three-quarter inches. None were taken in seventy-five and seventy-eight fathoms sixty miles S.E. by E. ¼ E. from Flugga, Shetlands, the nearest land being Whalsey Island, about fifty miles distant, nor at a point twenty-two miles east in eighty-five fathoms, in latitude approximately 61°; nor in sixty-five fathoms sixty-five miles S.E. by S. ¼ S. of Fetlar Island, the nearest land being about fifty miles distant. Nor were any plaice taken in the eleven hauls in from sixty-four to eighty-one fathoms, eastwards from the northern part of the coast of Aberdeenshire.

These facts, while they prove the absence of the smaller plaice from the deeper water, even in proximity to the coast, show that the adult fishes may migrate from it considerable distances into deep water. The deepest water in which any were procured was seventy fathoms, and the greatest distance from land was sixty-five miles, in sixty-five fathoms. The occurrence of plaice in the localities described, particularly near Fair Isle, and their absence from the other localities, is probably accounted for by the comparatively shoal water which extends for a considerable distance eastwards from the Orkneys and up towards Fair Isle, and which probably facilitates their wandering (Plate I.).

Of even greater interest are the phenomena presented by the plaice on the Great Fisher Bank. In the hauls made there last June, in thirty-four fathoms, about 170 miles E. by S. from Aberdeen, 519 plaice were taken in nine hauls, some being got in each, the number varying from eight to ninety-one—and plaice are said to have been some years ago much more abundant there than they are now. None of these plaice were small or unmarketable. The nearest land is Norway, but from the existence of the deep water along that coast and other reasons, it is improbable that the plaice in the region in question come thence. The distance from the Danish coast (at the Limfjord) is 160 miles, and it is probable that the plaice are derived from that quarter, or further south, reaching the Fisher Bank *viâ* the Dogger. Our east coast is cut

off from it by The Gut, and is more distant. The Fisher Bank plaice must at all events travel a long distance from the beaches in the course of their growth.

That plaice do travel great distances has been shown by the experiments I made some years ago by marking large numbers in the Firth of Forth and neighbourhood. It was found that they migrated northwards along the coast, and some which had been liberated in the Firth of Forth were caught a year and more afterwards in the Moray Firth, more than 150 miles from the place where they were set free. Still later, another was re-taken near Dunnet Head, on the north coast of Caithness, near the Orkney Islands, which must have travelled at least over 200 miles from the place of liberation. In all these cases the movement of the plaice was in a direction opposite to the prevailing surface current.*

From observations I have made on the rate of movement of the plaice confined in the large tidal-tank at the Bay of Nigg Laboratory, some idea may be gained of the distance that might be covered in a short period. The plaice there are tame and swim leisurely around the tank near the surface, especially at feeding time, and I found that while gently swimming in this way they moved at the rate of from 100 to 140 feet in a minute. This leisurely movement, if continued for one hour, would take them a distance considerably over a mile; when disturbed, as by pushing a stick into the water, they dart off with great rapidity. Since the smallest plaice taken on the deep-water grounds was some years of age, it is easy to understand how a distance of 50 or 100 miles can be traversed by them by a leisurely movement, even if it were accomplished at long intervals.

Flounder (*Pleuronectes flesus*).

In the hauls on the trawlers comparatively few flounders were taken, and they were for the most part large, although not always taken to market. From the known habitat of this fish—more shore-loving and estuarine than the plaice in its early stages, and never wandering into deep water when adult—this was to be expected, and the observations made are chiefly of interest in connection with its migrations from the shallows into moderately deep water.

The facts establish two well-marked migrations of the flounder from the shallow water to the deeper water, one in early spring and the other in autumn. The statistics of the "Garland" may be first summarised. At the seven stations in the Firth of Forth, in 575 hauls of the net throughout the year for ten years 1886–1895, the 321 flounders taken were thus distributed in the different months; the Table also shows the distribution of the flounders taken in St. Andrews Bay in the same period, and in the Moray Firth by the "Garland" in the years from 1886 to 1900:—

* *Eleventh Ann. Rep., Part III.*, p. 186. *Fifteenth ibid.*, p. 374.

[Table.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Forth—												
No. - - -	4	21	104	114	36	23	3	3	4	0	0	10
Av. per haul, -	0·1	0·4	2·6	2·3	0·7	0·4	0·07	0·05	0·08	0·0	0·0	0·2
St. Andrews—												
No. - - -	0*	11	112	230	94	79	19	90	1	30	16	3
Av. per haul, -	0·0	0·7	4·7	14·4	7·8	3·3	1·0	4·5	0·1	1·1	0·8	1·6
Moray Firth—												
No. - - -	0	11	.	15	2	0	10	12	9	0	0	0
Av. per haul, -	0·0	2·5	.	3·0	0·08	0·0	0·7	1·2	0·6	0·0	0·0	0·0

* Seven hauls. In the Moray Firth five hauls were made in January, none in March—which would have given a high average—19 in June, 19 in October, 12 in November, and four in December.

These figures show how the numbers rapidly increase in February, March, and April, and diminish in May and June, increasing again slightly in August.

The particulars of the flounders taken by the trawlers employed in the inshore waters of the Moray Firth and Aberdeen Bay may be contrasted with those of the "Garland," but no hauls were made in the month of April in either of the areas named, and not in Aberdeen Bay in August :—

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Aberdeen Bay—												
No. of hauls, -	2	1	3	.	8	5	7	.	3	2	12	12
No. caught, -	0	1	14	.	33	6	5	.	10	87	143	5
Av. per haul, -	0·0	1·0	4·7	.	4·1	1·2	0·7	.	3·3	43·5	11·9	0·4
Moray Firth—												
No. of hauls, -	3	18	14	.	18	18	5	14	10	14	27	23
No. caught, -	0	220	786	.	1	0	11	194	0	0	2	9
Av. per haul, -	0·0	12·2	56·1	.	0·06	0·0	2·2	13·9	0·0	0·0	0·07	0·4

It is evident from these figures that the migration a little offshore in spring is very marked, and that there is also a migration of the same kind in autumn much less considerable, and not quite corresponding in the period in the different regions so far as these hauls show. The spring migration is for spawning, the spawning period being in Feb-

ruary, March, April, and May, and the fishes which are taken at this time are large and ripe, *e.g.* in February and March in the Moray Firth they were very large and spawning. In March 342 were taken in a single haul in the Dornoch Firth, in from twelve to sixteen fathoms, and other three hauls yielded 148; of the total of 490 flounders only 54 were rejected as unmarketable, although mature fishes. In Spey Bay in four hauls 255 were caught, of which 219 were taken to market. In February eight hauls in Burghead Bay, in from seven to thirty fathoms, yielded no flounders; three hauls in the same place at the middle of March, in from seven to twelve fathoms, produced 39, all large and marketable. In four hauls in the Dornoch in February, in six to twelve fathoms, 215 were caught, all taken to market; in March, as stated, the four hauls in the same place produced 490.

There is some evidence as to the depths and distance from shore that may be reached by the flounders in their spawning migration. As a rule they do not go above two or three miles from shore if the water is of suitable depth; but in some cases they may travel much further. Thus, while none were taken in numerous hauls on Smith's Bank in the summer and autumn, two large individuals were got there on 19th March in one of five hauls in from nineteen to twenty-eight fathoms, the nearest shore being about twelve miles distant, and a channel of deep water, exceeding thirty fathoms, intervening between it and Smith's Bank. Two large ones were also taken on February 9th, in from twenty-five to thirty fathoms, six miles east of Cromarty. In some years also, flounders were taken by the "Garland" at the Firth of Forth Stations VIII. and IX.; the former in from twenty to thirty fathoms, two to seven miles from shore, the latter in twenty-nine to thirty-two fathoms, nine miles off. They mostly occurred at Station VIII. in March and April; in some years none were got in any month, and in 1889 forty-one were caught, some at both stations, a very unusual number, viz. nine in April, one in May, nine in June, thirteen in July, four in August, and five in October. None were taken at either station in that year in January, February, March, or November. On referring to the temperature observations, I find that in that year the bottom-temperature was above the mean in January and February, in January by 2·2° F.; in March it was normal, while in April, May, and June it was below the mean—in April by about 1° F., and in May by 2·3° and 2·0° F.; and in July, August, and October the temperature of the bottom water exceeded the mean, at Station VIII., by 1·6° F. in July, 1·9° F. in August, 1·7° F. in October, and 0·5° in November, and at Station IX. by 2·8° F. in July, 1·9° in August, 1·6° in October, and 0·8° in November.

With regard to the subsidiary autumn migration, the largest number of flounders was taken in the Dornoch Firth in August, viz. 194 in five hauls in from five to eleven fathoms; none were taken in June, eleven were got in July in seven hauls, none in September in two hauls, and none in October in twenty-six hauls. In Aberdeen Bay, on the other hand, the largest hauls were obtained in October and November in from six to sixteen fathoms; no hauls were made in August.

It thus appears that the adult flounders leave the shallow waters to spawn in spring in deeper water a little offshore, returning in June, and that later many of them again move off.

Common Dab (*Pleuronectes limanda*).

In some respects the plaice occupies an intermediate position between the flounder and the common dab. The quite young specimens of the

latter, while abundant in the shallow water on the beaches and estuaries, are not confined to them like the flounders and plaice, and may be got in numbers beyond the range of the young plaice. The adult is also more widely distributed, and is found in deeper water and further from the shore than the plaice, but the numbers are much reduced in the deeper water on the north-eastern grounds, where the long rough dab, witch, and megrim exist in greatest profusion. On the inshore grounds examined, in moderate depths, the dab is at least three times more abundant than the plaice. In Aberdeen Bay a number of hauls yielded 39,685 dabs and 12,475 plaice, and when it is borne in mind that a considerable proportion of the smaller dabs escape from the meshes of the net—they can be seen swimming about the net when it is hauled—it is evident the proportion is even greater than represented. In the Moray Firth the "Garland" caught altogether 24,615 dabs and 8813 plaice; at the six inshore stations the proportion was 1·3 dabs to one plaice, and at the outer stations in deeper water the proportion was 24·2 dabs to one plaice.

The hauls made in the "Dog Hole," off Aberdeen, in from fifty-five to seventy fathoms, yielded ten plaice and 383 dabs. On the north-eastern grounds the abundance of dabs is much less. In six hauls made in September, in sixty-five fathoms, sixty-five miles S.E. by E. of Sumburgh Head, the number taken was fifty-three; some were procured in each haul—from three to seventeen. In October none were got in a haul in 81 fathoms 97 miles N.E. of Buchan Ness, nor in 63 fathoms, 87½ miles N.E. But, as was the case with the plaice, on the grounds about eighteen to twenty-two miles south-eastwards from Fair Isle, in 65 fathoms, they were represented, 756 being taken in nineteen hauls, the plaice numbering 193. In the series of hauls made by the "Caledonia" in June, in from sixty-four to eighty-one fathoms, about eighty miles east from Buchan Ness, only two were caught, both taken in one drag in seventy-nine fathoms. In two hauls taken in May, about sixty miles S.E. by E. of Flugga, Shetlands, two were caught, both in seventy-eight fathoms. In a haul twenty-two miles east from Flugga, in eighty-five fathoms, none were got; but in four hauls in sixty-five fathoms, about fifty miles from the Shetlands—a ground which yielded no plaice—no less than 1188 were taken, one five-hours' haul producing 529 specimens. On the Fisher Bank the dabs were less numerous than the plaice, the nine hauls yielding only twenty-six.

The common dab may spawn far from shore and in deep water, for on 19th May most of those caught in the hauls in sixty-five fathoms, fifty miles from land, were found to be nearly quite ripe, and some were spawning. Ten females and five males which had passed through the meshes of the otter-trawl and were caught in the small-meshed net were subsequently examined and measured. They were all approaching ripeness, the females ranging in size from 137 to 174 mm. (5½–6⅞ inches) and the males from 99 to 137 mm. (3⅞–5½ inches). The temperature of the bottom-water was 42°·5 F., and of the surface 46°·6 F.

While that is so, however, comparatively few young dabs were taken in the small-meshed net in the deeper water. On the inshore grounds they were taken in great profusion, as small as from 32 or 34 mm. upwards in May, and under 40 mm. in September and October; but offshore the smallest individuals were much larger. For example, in the haul above referred to the smallest was 99 mm.; and in the September hauls, south-east of Sumburgh Head, only six common dabs were found in the small-meshed net, and they measured from 120 to 150 mm., while there was a profusion of small long rough dabs from 28 mm. and upwards. In the haul on 31st August in the same place

there were nine, from 123 to 190 mm. The number taken in the small-meshed net in two drags in October, in sixty-five fathoms, off Fair Isle, was 38, measuring from 82 to 179 mm. ($3\frac{1}{4}$–7 inches). In a drag in eighty-five fathoms, east of Flugga, none were obtained in the small-meshed net. The small dabs were more abundant but not numerous at the "Dog Hole," off Aberdeen, those taken in the fine-net in August measuring from 92 mm. upwards, in November 77 and 105 mm., and in December from 94 mm. In eighty-five fathoms about eight miles from Kinnaird Head only one was got in July, and it measured 171 mm.

From the relatively smaller abundance of the adults in the deeper water, one would not expect the young to be in great numbers, but it is surprising that none should have been procured. It is probable that many or most of the common dabs found in the deep water at a distance from shore make their way there from the shallower waters as the plaice does. We know that the dab may move considerable distances in a comparatively short space of time. As a result of the labelling experiments to ascertain the extent of their wanderings, I stated in the Eleventh Annual Report* that "it would appear from these experiments that the common dab is much more active than the plaice, that it moves freely about the territorial waters, going considerable distances in comparatively short periods, and travelling indifferently in any direction offshore, or inshore, or along the coast." Some of the labelled specimens travelled thirty-seven and twenty-nine miles.

Lemon Dab (*Pleuronectes microcephalus*).

This flat-fish occurred in very many of the hauls, but only rarely in any considerable numbers, and then for the most part in deepish water in the neighbourhood of hard bottom. It seems to be widely scattered about the North Sea, small forms being intermixed with the large individuals. In Aberdeen Bay the few captured showed a considerable proportion of unmarketable, viz. fifty, to eighty-two marketable, and this occurred throughout the year. In the Moray Firth they were got on most of the inshore grounds sparingly, but in considerable numbers off Lybster and Dunbeath in sixteen to twenty-four fathoms. Six hauls there in October, in twenty-two to twenty-seven fathoms, yielded 1106 lemon soles, 952 marketable and 154 unmarketable. In November 179 were taken in one haul off Lybster, eighty-four of which were of marketable size, and in January four hauls gave 232, all but twenty-three being marketable. In May one haul yielded six, all unmarketable. They also occur in considerable numbers on Smith Bank at certain times. In May eighty-two were taken in a haul, all but two of which were marketable. In June five hauls produced sixty, of which eleven were unmarketable; in November an hour's drag yielded twenty marketable forms, and in March four drags furnished 238, all except ten of which were marketable. At the outer stations of the "Garland" in the Moray Firth 1251 lemon dabs were taken in 147 hauls, or an average of 8·5, while at the stations near shore 427 were caught, the average being 2·6. The numbers taken at the "Dog Hole" off Aberdeen in depths of from 57 to 70 fathoms contrast with those got in Aberdeen Bay; eight hauls yielded 374, of which all but twenty-five were marketable.

On the deep-water grounds in the north-east, lemon dabs were scantily represented. None were taken in the haul in eighty-one

* *Part III.*, p. 187

fathoms, ninety-seven miles north-east of Buchan Ness, but in the nineteen hauls near Fair Isle in October, in sixty-five fathoms, 179 were taken, twenty-six being unmarketable. In May, to the east of the northern part of the Shetlands, in two drags in seventy-five and seventy-eight fathoms, one was obtained which was unmarketable; and in the haul in eighty-five fathoms, twenty-two miles east of Flugga, another was taken, too small to be marketable, as well as two 113 and 117 mm., in the small-meshed net. They were caught also further south off Sumburgh Head in sixty-five fathoms, where four hauls in May furnished seven, and six in September five, two of which were unmarketable. Seven hauls in sixty-nine fathoms about fifty to seventy miles off the northern coast of Aberdeen yielded only one; and ten hauls in from fifty-eight to seventy-eight fathoms, in May, east and south-east of Sumburgh Head, furnished ten, one being unmarketable. Twelve were obtained in the nine hauls on the Fisher Bank at the beginning of June, one being unmarketable. The largest taken in the deep water was 45·4 cm. ($17\frac{3}{4}$ inches); many measured from fifteen inches up to these; few were under twelve inches, and the five smallest were 174, 180, 189, 192, and 105 mm. (or above $6\frac{3}{4}$ inches).

Very small lemon dabs are very rarely taken. Holt has described incompletely metamorphosed specimens about an inch in length, taken in a shrimp trawl at depths of sixty-two and eighty fathoms, in August, off the south-west coast of Ireland; and later he found specimens from a length of two to about four inches in the estuary of the Humber.* I have also described specimens of two inches from twenty fathoms of water,† and Cuningham found a very large number of young lemon dabs on the Essex coast in June in from two to five fathoms, measuring from three to five inches.‡ In the course of the investigations with the small-meshed net on board trawlers no large haul of young lemon dabs was obtained, and indeed few that were very small were secured. Moreover it appears, as already stated, that the smaller forms are found scattered about like the adults. In many cases none were obtained in the fine-net, and usually when present only from one or two to half a dozen.

In Aberdeen Bay one taken in July measured 183 mm. ($7\frac{1}{4}$ inches); in August, of five, the smallest was 126 mm. (5 inches), and the largest 175 mm.; in September three measured 112 mm. ($4\frac{3}{8}$ inches), 134 and 187 mm.; in November in one haul two measured 114 and 176 mm., and in another haul on the 9th in nine fathoms, one 91 mm. ($3\frac{5}{8}$ inches) was obtained. In December in several hauls a few were got, the smallest measuring 137 and 148 mm. At the "Dog Hole," in deeper water, small lemon dabs were occasionally taken, but often there were none. In August, when 118 were taken altogether in both nets in fifty-eight fathoms, the smallest measured 107 mm. ($4\frac{1}{4}$ inches), the next of the seventeen got in the fine-net being 109, 113, 117, 118, 122 mm., &c. On 30th July three were taken of 114, 118, and 131 mm. In the deep hole off Kinnaird Head, about eighty-five fathoms, one was secured which measured 143 mm. On the north-eastern grounds, the two got in eighty-five fathoms in May, east of the Shetlands, measured 113 and 117 mm. Some got by the "Garland" in the Moray Firth, Firth of Forth, and Clyde were smaller. In May in the Forth, in eight to ten fathoms, specimens of 104 mm. ($4\frac{1}{8}$ inches) the next being 118 and 119 mm.; in August the smallest

* *Journ. Mar. Biol. Assoc.*, iii., p. 399; 1885.
† *Eighth Ann. Report, Part III.*, p. 168; 1889.
‡ *The Natural History of the Marketable Marine Fishes of the British Islands*, p. 241.

measured 96 mm. ($3\frac{3}{4}$ inches), 100, 106, 107, and 125 mm. In twenty to thirty fathoms in July the smallest procured was 102 mm. In the Moray Firth in April and June the smallest were 105, 110, 118, and 138 mm. In the Clyde in March, in twenty-five fathoms, males as small as 84 mm. ($3\frac{3}{8}$ inches) and 87 mm. were taken, and in October others which measured 87, 96, and 97 mm. It is noteworthy that in the numerous catches of the shrimp-boats in the Solway Firth which I examined throughout the year no lemon soles were present.

The rarity of the small lemon dabs under four inches may be due to some extent to the inefficiency of the apparatus used in most cases. The meshes of my fine-net were certainly small enough to take them much under that size, and did in fact capture large numbers of dabs and long rough dabs very much smaller. But it is possible that the small individuals are not always raised from the bottom by the ground-rope, especially of the larger trawl-nets. When small flat-fishes kept in tanks are disturbed or frightened they bury themselves in the sand, only the eyes remaining visible; and if they do so when the ground-rope approaches, or disturbs them, it will pass over them. Larger forms no doubt also bury themselves, but when the ground-rope touches them they dart forwards and upwards, getting above it and into the net. The lemon dab, however, prefers hard ground, and it is not improbable that the smaller forms exist in greater numbers in places where the trawl cannot be used.

There is one remarkable circumstance about the lemon dab which was noticed, viz., the occasional occurrence of ripe individuals both male and female of an exceptionally small size. As a rule few females have been observed to be mature under nine or ten inches. Holt found one mature at eight inches on the Irish coast; and Cunningham gives 8·2 and nine inches as the lower limit. Holt first fixed ten inches and then twelve inches as the limit between mature and immature, the latter for the North Sea. The male is stated to become mature at a smaller size and as small as six inches.* The following are records of much smaller ripe specimens of both sexes. In a haul made in the Clyde on 5th September, in twenty-five fathoms, east of Rhuad Point, Cantyre, forty-three lemon soles were taken. Among them were two recently spent females measuring twelve and three-quarters, and eleven and a quarter inches, the others ranging from 212 to 114 mm. ($8\frac{3}{8}$–$4\frac{1}{2}$ inches). I found one female, 173 mm. in length and weighing 57·7 grammes, just spent, some mature eggs being still in the cavity of the ovary. Another 147 mm. in length ($5\frac{3}{4}$ inches) contained fully ripe eggs and was spawning; the weight of the fish was 26·03 grammes; and another 171 mm. in length and weighing 53·15 grammes was also spent. The others were immature, those of 141, 137, 137, 123, and even 166 mm., having very minute eggs. In other hauls made in from twenty to thirty-five fathoms, between Sanda Island and Bennan Head, four or five miles south of Ailsa Craig, on 14th March, a male 138 mm. ($5\frac{1}{2}$ inches) long was quite ripe, and two 84 mm. ($3\frac{5}{16}$ inches) and 87 mm. ($3\frac{7}{16}$ inches) were very nearly ripe, the testes being large and white. A female 115 mm. ($4\frac{1}{2}$ inches long) had eggs measuring 0·14 mm.

Several small mature specimens were also obtained in the Moray Firth. On 14th June, in thirty fathoms, fifteen miles E.S.E. of Tarbet Ness, a female, 138 mm. ($5\frac{7}{8}$ inches) was found to be mature with quite ripe eggs flowing; the weight of the fish was 22·6 grammes, or considerably under one ounce, and the weight of the ovaries 1·45 grammes.

* *Eighth Ann. Report, Part III.*, p. 162 (1889); *Tenth ibid.*, p. 239*a*. *Journ. Mar. Biol. Assoc.*, ii., pp. 218, 244 (1892); *ibid.*, iii., p. 377 (1895).

Another female, 145 mm. in length and weighing 26·9 grammes, was in the same condition, containing quite ripe transparent eggs; the weight of the ovaries was 2·8 grammes. A third of the same length was nearly ripe. Two males of 138 and 147 mm. were also nearly ripe. On the other hand, some females caught on 22nd June, eighteen miles from land, in thirty-five fathoms, measuring 118 and 132 mm., were quite immature, the eggs being only about 0·07 of a millimetre in diameter. Off Caithness in twenty-five fathoms, on the 3rd June, females of fifteen and sixteen inches and under were spawning, but the only small lemon dab discovered was a male 131 mm. ($5\frac{3}{8}$ inches) in length from which the spermatic fluid was flowing.

It would be of interest to determine whether these very small mature lemon dabs belong to a smaller "race" of the species.

Witch (*Pleuronectes cynoglossus*).

Only exceptionally in the inshore trawlings were specimens of this flat-fish obtained, and then the haul had been extended into moderately deep water. None were taken in Aberdeen Bay even in twenty or twenty-two fathoms. At the "Dog Hole," from eight to thirteen miles off, thirty were got in eight hauls, mostly in seventy fathoms. In the Moray Firth they were occasionally caught off Burghead, and less frequently in the Dornoch Firth, and particularly in the winter and spring months, when they appear to extend into more shallow water than in summer. In some of the deeper parts of the Moray Firth, where the bottom is soft and muddy, witches abound, various hauls, mostly for four hours, having yielded several hundreds. The influence of the depth in relation to the numbers, providing the bottom is suitable, is shown by the following series of hauls in February off Burghead and towards Cromarty:—(1) two in seven to twelve fathoms, 94 and 191; (2) one in ten to eighteen fathoms, 249; (3) four in twenty to thirty fathoms, 273, 423, 337, 322, the average being 338·5; (4) in twenty-five to thirty fathoms, 893, 279, 490, and 1079, the average being 685·2.

Only four were got in nine hauls on the Fisher Bank, in thirty-four fathoms, in June; but on soft muddy bottoms on the north-eastern grounds off the Shetlands they occur in profusion, although not so abundantly as a rule as in some parts of the Moray Firth. Thus, seven hauls in from seventy-six to eighty-one fathoms, about from sixty to ninety miles off the northern coast of Aberdeenshire, yielded 1574, thirty-six being too small to be marketable; in four hauls in the same region, but in sixty-four to seventy-one fathoms, 462 were taken, thirteen being unmarketable. In ten hauls somewhat further north, in May, in from fifty-eight to seventy-eight fathoms, 1253 were caught, fifty being unmarketable, and they were mostly taken in the deeper water. Four were taken in one haul in eighty-five fathoms, east of the northern part of the Shetlands; in eighty-one fathoms, further south, 164 were got in a haul, four being unmarketable. In this locality in sixty-five and sixty-six fathoms nineteen hauls gave 1231, eighty-two being unmarketable. The witch and megrim comprise almost all the edible flat-fishes caught on the north-eastern grounds, where trawling, for haddocks especially, is so largely pursued.

The number of small witches taken in commercial trawling is comparatively slight, the thin, narrow, pliant fish easily escaping through the meshes of the net. It is uncommon to find any so small as five and a half inches in the trawl-net, the usual limit being about eight inches. The proportion of small unmarketable specimens among 9368 was 796,

or about one in twelve; the number rejected in the Moray Firth was relatively greater than on the north-eastern grounds—viz., about one in eight as compared with about one in twenty-two, showing probably that the relative abundance of the smaller witches is greater in the Moray Firth than on the deep-water grounds offshore.

The smallest examples procured in the small-meshed net in May, in eighty-five fathoms, off the Shetlands, was 200 mm. ($7\frac{7}{8}$ inches), but on neighbouring grounds others were obtained measuring 169, 176, 183 mm. ($6\frac{5}{8}$–$7\frac{3}{8}$ inches). In December, in seventy-five fathoms, about seventy miles S.E. by E. of Sumburgh Head, only one was got in my net, and it measured 126 mm. or five inches, the smallest in the ordinary net being 208 mm. On 10th March, about 75 miles east of Balta Sound, midway between the Shetlands and Norway, in 70 fathoms, a very small witch was obtained in my fine net. It measured 59 mm., or $2\frac{3}{8}$ inches. It was probably approaching one year of age. At the Dog Hole, off Aberdeen, specimens of 114 and 118 mm. were taken on 30th July, and others of 107, 109, 113, and 117 mm. on 21st August.

In the Clyde the "Garland" has obtained specimens of 106 and 114 mm. Holt has taken young witches about $1\frac{1}{16}$ inches long in eighty fathoms, off the Skelligs, on the coast of Ireland, in August.

On the grounds south-east of the Shetlands they were found to be spawning in May. The largest specimen I measured was 62·1 cm. or about $24\frac{1}{2}$ inches, but individuals above twenty inches are uncommon. The witch was obtained by Bourne in 200 fathoms off the Irish coast, and it has been got in over seven hundred fathoms.

Megrim or Sail-fluke (*Lepidorhombus whiff*).

This fish was taken in less numbers than the witch, and like it mostly in the deeper water offshore. Only two were got in Aberdeen Bay in ten fathoms in December, and only a few in the Moray Firth, where 308 hauls by the "Garland" yielded forty-one specimens. Two were taken in the Dornoch Firth in November in from seven to thirteen fathoms, and nine off Dunbeath and Lybster in eighteen and twenty-four fathoms in January. Like the witch it seems to extend more into the inshore waters in winter. In fifty-five to seventy fathoms, off Aberdeen, sixty-six were caught in eight hauls in May, June, July, August, November, December, and January, all but two being marketable. No megrims were taken in the nine hauls on the Fisher Bank in June. On the north-eastern grounds they were taken in the greatest depths worked at—up to eighty-five fathoms—and they were most numerous, and more so than the witches, at the places furthest north-east. For example, in three hauls in seventy-five to eighty-five fathoms, east of the northern part of the Shetlands, in May, only four witches were taken in the otter-trawl and 251 megrims, sixty-four of which were too small to be marketable. Still further north-east, about 275 miles from Aberdeen, or eighty miles north-east from the northernmost point of the Shetlands, approximately in Lat. 61° 15′, they were found in May in numbers, along with witches, haddocks, and picked dogfish, two hauls producing six baskets of large haddocks, two and a half of mediums and small, three of whitings, and five of megrims and witches, as well as 145 picked dogs. Only the unmarketable fishes were in this case enumerated, but as the number of megrims of this class was 106 and of witches eight, while the proportion of unmarketable to marketable is about the same among witches as among megrims, it is evident the latter were in much greater numbers. The smallest megrims in this case measured 163, 173, 182, 184, and 186 mm., or from $6\frac{7}{16}$ inches upwards. I am

informed by the trawlers that they get numbers of megrims beyond the 100-fathom line.

No very small megrims were procured in the fine-meshed net. The smallest in a haul in eighty-five fathoms in May was 114 mm. ($4\frac{1}{2}$ inches), the others, thirty-three in number, ranging up to 206 mm. ($8\frac{1}{8}$ inches). Others were taken in October off Fair Isle which measured 145, 154 mm., &c. Holt has described young megrims nearly transformed, from 19 mm., and others at various sizes. They were got in deep water (80 fathoms) off the Skelligs in August, and others, from three to a little over five inches, in about thirty fathoms in Ballinskelligs Bay.

The megrim, it may be said, was got in all the hauls in the deep water off the Shetlands, and the numbers in different hauls did not exhibit so great fluctuations as with the witch. It seems to be more regularly distributed.

Scald-fish (*Platophrys laterna*).

No specimens of this species were obtained on the East Coast either in the otter trawl-net, small-meshed net, or shrimp-net. Thirteen specimens were got in the Clyde in October, November, and December. They measured from 103 mm. to 123 mm.; five were females, seven were males, and the sex of the other was not determined.

Turbot and Brill (*Bothus maximus*, *Bothus rhombus*).

Not very many turbot were obtained in the hauls on board trawlers; but a considerable number of brill were caught both in Aberdeen Bay and especially in the Moray Firth. The total number of brill procured during the investigations on board trawlers was 513 and the aggregate of turbot was 95, the brill thus being about 5·4 times more numerous. The figures show approximately the relative abundance of these two forms on the inshore grounds worked over—that is between about five and twenty fathoms, but mostly between six and seven and fifteen or sixteen fathoms. Had the investigations been carried on more extensively in water somewhat deeper, the proportion of turbot would have been slightly raised, because there is evidence that the turbot passes out further from shore than the brill does. The "Garland, it may be said, during the trawling investigations in the Moray Firth between 1886 and 1900, during which 308 hauls were made, caught sixteen turbot and forty-eight brill, the proportion being here as 1 to 3. Putting other reasons aside, the proportion at the inner stations, in the bays and territorial waters, was one turbot to 3·8 brill, and in the outer stations one turbot to 1·7 brill. The number of turbot and brill obtained at any time by the "Garland" was small, but it is of interest to note that the proportion between the two species in the Firth of Forth and St. Andrews Bay differs from that for the Moray Firth, the turbot in both the former localities exceeding the brill in numbers in the ratio of about 1 to 0·6.

As a rule only one or a few of either, more particularly turbot, were taken in a haul, but sometimes the number was much larger, as many brill, for example, as seventeen, eighteen, twenty-two, and twenty-three being taken in a single haul, while the maximum number of turbot was eleven—in between six and seven fathoms in Aberdeen Bay in November. In some cases, particularly in the Moray Firth—and these chiefly at Burghead Bay—very considerable numbers were taken in winter when herrings and sprats, or both, were on the ground, the

turbot and brill being predaceous and living to a large extent on these clupeoids, as well as on the sand-eel.

I give in the following Table the particulars for the two places; in the Moray Firth the hauls at different localities are combined.

	Aberdeen Bay.					Moray Firth.				
	No. of Hauls.	Turbot.	Brill.	Herrings.	Sprats.	No. of Hauls.	Turbot.	Brill.	Herrings.	Sprats.
January, .	2	.	1	.	.	11	2	27	9	1
February, .	1	.	.	.	.	18	3	19	83	12
March, .	3	.	.	.	.	19	1	29	8	22
April, . .	.	.	.	.	.	.	.	.	.	.
May, . .	5	.	3	6	.	18	17	25	4	.
June, . .	11	1	28	5	2*	18	2	7	.	.‡
July, . .	7	9	7	99	1†	14	4	1	11	29
August, .	.	.	.	.	.	14	.	6	.	.
September, .	5	5	1	.	.	10	2	11	.	.
October, .	8	1	3	.	.	12	.	.	.	.
November, .	17	17	3	.	.	32	.	106	17	.
December, .	17	1	1	10	.	36	27	233	141	.

* One sand-eel. † Three sand-eels. ‡ Sand-eels.

The number of brill and turbot caught, mostly at Burghead Bay, in November, December, and January was considerable; in the two former months sprats were also known to be on the ground. The hauls, indeed, in these months are of much interest as showing the extent to which the presence of herrings and sprats causes predaceous fishes to assemble to prey upon them. In thirteen hauls in December, for example, while haddocks and whitings were almost absent, 383 large cod, 406 codlings, mostly large and all marketable, and 233 anglers were taken on the ground frequented by the herrings and sprats, the averages per haul being 29·31 and 18—far above the usual. The herrings and sprats included in the Table were all caught in the ordinary trawl-net, but in the small-meshed net very large numbers were taken, and this sometimes happened at times when none were got in the ordinary net. The use of a net of this kind may thus throw light upon changes in the abundance of many fishes at a certain place and time, the cause of which might otherwise remain obscure or be erroneously interpreted. It some instances, as at Sinclair Bay in June, it was found to be sand-eels which were attractive to the brill.

None of the turbot taken, and only one of the brill, was so small as to be unmarketable, showing that the young of these species under about nine inches are not usually found within the limits of th depths stated when the trawling occurred.

No brill were found at the Dog Hole, on the Fisher Bank, or on the north-eastern grounds, and no turbot were got in the nine hauls on the Fisher Bank. Two, however, were taken in a haul at the Dog Hole, $12\frac{3}{4}$ miles off Aberdeen, in seventy fathoms, on 5th November; one

in sixty-four fathoms in June about sixty miles from the northern coast of Aberdeen; and one, 26 inches in length, in seventy fathoms, near the Viking Bank.

Thus the turbot, like the plaice, extends its wanderings into comparatively deep water at a distance from the land.

Halibut (*Hippoglossus vulgaris*).

Very few halibut were obtained in the course of the investigations—viz., ninety-six—and they were nearly all small. Most of them were taken in the deep-water voyages off the Shetlands, sixty-three in number, their sizes ranging from $17\frac{1}{2}$ to $49\frac{1}{2}$ inches, and running almost always between twenty and thirty inches. They were got most plentifully in the hauls off Fair Isle, in sixty-five fathoms, in October. Six were taken in the nine hauls on the Fisher Bank, in thirty-four fathoms, at the end of May and beginning of June, and all were small. The number obtained in the Moray Firth was eighteen, taken in January, February, March, May, June, October, November, and December; and fifteen were procured in Aberdeen Bay in May, June, November, and December. None were taken in fifty-three hauls in the Moray Firth and Aberdeen Bay in July, August, and September, probably indicating that the small halibut at this period move off into deeper water, although it cannot be said that they are numerous at any time in the shallower areas which were investigated. These smaller forms, when taken, are usually found near rocky ground. Only one of them was too small to be marketable. No halibut, it may be said, were procured in the eight hauls in from fifty-three to seventy fathoms at the Dog Hole, off Aberdeen. The smallest halibut I obtained were these:—In the Dornoch Firth in December, one measuring 35·3 cm. (14 inches), and weighing $15\frac{1}{2}$ oz.; in Aberdeen Bay, in from eight to eighteen fathoms, on 1st November, one of 188 mm. ($7\frac{3}{8}$ inches); off Dunbeath, Caithness, in October, one of 285 mm. ($11\frac{1}{4}$ inches).

The trawlers working on the north-eastern and northern grounds always bring in a few halibut, mostly small—ranging about the sizes stated above, and occasionally a large one is included in the "shot." They are much more abundant on the Faröe and Iceland grounds. I have seen a "shot" from Iceland landed by a foreign trawler which included many hundreds and perhaps thousands of small halibut, many of them no larger than flounders. The supply of halibut, however, mostly depends upon the liners.

Little Sole or Solenette (*Solea lutea*).

This small pleuronectid was obtained occasionally in the ordinary trawl-net, particularly in the Moray Firth, and also in the shrimp-net and small-meshed net. Specimens were obtained in the Dornoch Firth, off Lossiemouth, and in Burghead Bay in April, June, August, November, and December, in from five to fifteen fathoms, and off Lybster, Caithness, in November, in twenty-three or twenty-four fathoms. Forty-five specimens were caught in the Moray Firth, besides a number by the "Garland"—as many as twenty-two and fifteen in a haul for an hour—in December, in ten to twelve fathoms, off the Suters of Cromarty. In July, some years ago, the "Garland" found large numbers spawning on Smith Bank, sixty in one haul.*

In Aberdeen Bay it was much more rare, ten specimens being taken in October, November, and January. It appears to be still rarer

* *Seventh Ann. Rep., Part III.*, p. 191.

further down the east coast of Scotland. Two specimens are stated to have been procured in St. Andrews Bay, and also pelagic eggs believed to belong to this species,* but no specimen appears to have been ever found in the Firth of Forth, notwithstanding the close examination of that area, although three single eggs from the Forth—in March, April, and August—have been described as belonging to this species.† It is stated by Cunningham to be common on the eastern grounds in the North Sea and the Brown Ridges, and Petersen describes it as occasionally occurring in Danish waters within the Skaw.‡ It is also fairly common on the south and west coasts of this country, and was frequently taken by the "Garland" in the Clyde. It appears, however, to be about as abundant in the Moray Firth as in the Clyde, and the peculiarity of its distribution on the East Coast is noteworthy. Those on the northern part of the East Coast, as the Moray Firth, may have spread from the west around the north coast of Scotland. The largest noted by me measured 138 mm. ($5\frac{7}{16}$ inches).

Black or Common Sole (*Solea vulgaris*).

This fish is rare on the East Coast, and its rarity increases as one goes north. In the course of the investigations seven specimens were procured, three in Aberdeen Bay and four in the Moray Firth. One was taken in June, two in October, two in November, one in December, and one in February. The "Garland," in 308 hauls in the Moray Firth, procured two black soles, while further south, in St. Andrews Bay and the Firth of Forth, twenty-three were taken in about a thousand hauls. It is much more common on the West Coast.

Cod (*Gadus callarias*).

Cod, either adult or young, or both, were taken in most hauls of the net both inshore and offshore at all seasons, but usually not abundantly, unless there was a special cause for their congregation together. The proportion between the adult cod and the codlings, and between the marketable (or large) and the unmarketable (or small) codlings, however, varied very much.

The total number of cod and codling taken in Aberdeen Bay in the hauls with the otter-trawl in the course of the investigations was 1841, of which 471 were cod, 1084 marketable codling, and 286 unmarketable codling. In the Moray Firth the aggregate number was 5059, 1767 being adult cod, 2337 marketable codling, and 955 unmarketable codling.

The averages for each class per hour's fishing in each of the months in the two areas are as follows :—

* M'Intosh and Masterman, *op. cit.*, p. 398.

† *Twelfth Ann. Rep., Part III.*, pp. 298, 299 ; *ibid., Fourteenth*, p. 226.

‡ *Report of the Danish Biol. Station, iv.*, p. 46.

[Table

	Aberdeen Bay.					Moray Firth.				
	Duration of Fishing.	Cod.	Codling.		Total.	Duration of Fishing.	Cod.	Codling.		Total.
			I.	II.				I.	II.	
	H. M.					H. M.				
January,	8 10	4·4	0·2	0·2	4·8	36 50	4·0	8·2	7·1	19·3
February,	4 0	0·2	3·2	0·0	3·5	75 5	4·4	3·5	0·3	8·2
March, -	12 5	14·9	27·1	0·0	41·9	65 45	8·9	4·8	0·4	14·3
April, -	.	.	.	.	.	.	.	.	.	.
May, -	16 35	2·4	0·6	0·2	3·0	73 30	0·8	2·1	1·7	4·6
June, -	20 –	1·5	0·1	0·4	2·1	23 40	1·3	2·4	0·6	4·3
July, -	21 47	0·5	0·2	3·3	5·6	53 20	0·4	0·02	0·2	0·7
August, -	.	.	.	.	.	38 50	0·6	0·08	0·5	1·2
Sept., -	9 54	0·4	0·9	7·2	8·5	25 20	0·5	0·04	6·1	6·8
October,	28 10	0·5	23·3	2·6	26·4	72 20	0·4	6·1	0·6	7·1
November	32 35	1·8	0·6	0·6	7·3	103 –	1·3	3·6	2·1	7·0
December	1 0	.	1·0	.	1·0	67 –	5·7	6·4	0·8	12·8
	158 16	3·0	6·8	2·0	11·6	634 40	2·8	3·7	1·5	7·9
Per cent. of total,		25·5	58·9	15·5			34·7	46·2	18·7	

It will be observed that the number of cod visiting the inshore grounds in the winter months is considerably greater than in summer, although the averages for corresponding months do not agree in the two areas. This, however, could not be expected, inasmuch as the quantity of fishing in different months differed in the two areas, and in the Moray Firth the hauls offshore are combined with those in the bays. The absence of information for April in the Moray Firth is regrettable, but the high average there for March was caused partly by considerable numbers being taken on Smith Bank, where spawning occurs, and partly by large catches in the Dornoch, where herrings and sprats were present at the time. The small proportion of the unmarketable codlings is noteworthy, amounting in Aberdeen Bay to 15·5 per cent. and in the Moray Firth to 18·7 per cent. of the total. The larger marketable codlings, ranging from about a foot up to the cod in size, constitute in both areas the greater part of those captured, the percentage in the Moray Firth being 46·2, and in Aberdeen Bay 58·9. They, like the cod, were also most abundant in the winter months, and, like them also, scantily represented in summer. At this period they are probably to be found in greater numbers offshore where the herrings are.

In the eight hauls made at the Dog Hole, off Aberdeen, in from fifty-five to seventy fathoms, 263 cod and codlings were taken, twenty-two being cod, 156 marketable codlings and 85 unmarketable; the percentages are respectively 8·3, 59·3, and 32·3, and the average per hour's fishing 2·3, 16·4, and 0·9 the average for all classes being 27·6. The hauls were made in May, June, July, August, November (two), December, and January, and the averages for these months are as follows:—

	Duration of Fishing.	Cod.	Codling.		Total.
			I.	II.	
	H. M.				
15th January, . .	1 –	2·0	6·0	2·0	10·0
13th May, . . .	1 5	0·9	13·7	0·0	14·5
28th June, . . .	1 10	7·5	0·0	8·4	15·8
30th July, . . .	1 6	4·5	26·4	15·5	46·5
21st August, . .	1 23	0·8	17·0	36·1	53·9
5th, 28th November, .	2 50	1·4	8·9	1·4	11·8
16th December, . .	1 –	0·0	59·0	5·0	64·4
	9 34	2·3	16·4	0·9	27·6
	Per cent.	8·3	59·3	32·3	.

It will be found on comparing the averages with those given above for Aberdeen Bay in corresponding months that the large cod in summer were more numerous offshore; in most cases also the large codlings were more abundant, and in all cases the small codlings. The number of hauls, however, is small.

In the nine hauls made on the Great Fisher Bank at the beginning of June, in thirty-four fathoms, the cod was not very abundant, the total number taken being 131, or 3·6 per haul; adult cod numbered fifty-two, the average per haul being 1·4; marketable codlings numbered 34, with an average of 0·9, and the small unmarketable codlings forty-five, the average being 1·2. The percentages were—adults, 39·7, large codling 26·0, and small codlings, 34·3. The averages for large cod were very much the same in Aberdeen Bay and the Moray Firth in the corresponding month, viz. 1·5 and 1·3; those for the larger codlings were less in Aberdeen Bay and greater in the Moray Firth; and those for the smaller codlings were less in both places.

The younger codlings were most abundant actually and relatively on the Fisher Bank.

In the hauls taken in the deep water on the north-eastern grounds the proportions were different. In those made towards the end of May in from fifty-eight to seventy-six fathoms, to the south-east of the Shetlands, the average number of cod taken per hour was 1·0, of marketable codlings 19·4, and of the small unmarketable codlings 0·3, the average for all sizes being 20·7. The percentages were respectively 4·7, 93·8, and 1·5, showing a relatively great preponderance of the larger codlings. In the hauls made in June further to the south, off the northern coast of Aberdeen, in from sixty-four to seventy-one fathoms, the preponderance was not so marked. The average for the large cod was 3·1, for the large codlings 4·9, and for the small codlings 0·2, and the percentages were 47·6, 59·4, and 3·0. In the same region, but in somewhat deeper water, viz. from seventy-six to eighty-one fathoms, the relative abundance of large codling was greater. The averages per hour were, for cod 2·4, for large codlings 19·8, and for small codlings 0·5, and for all sizes 22·9. The percentages were, for cod 10·8, for large codling 86·9, and for the small codling 2·3. In a

few hauls made in September in the same region, but further north—about sixty-five miles to the south-east of Sumburgh Head, the general average for all sizes was 6·9; that for cod was 11·0, for large codling 88·5, and for small codling 0·0. In October about twenty miles south-east of Fair Isle, in sixty-five fathoms, the average for all sizes was 9·5; for cod it was 1·9, for large codlings 7·4, and for small codlings 0·17, the respective percentages being 19·7, 78·4, and 1·9. In the following Table I give these figures in comparison with those for Aberdeen Bay and the Moray Firth when the month is comparable:—

Month	Place.	Depth	No. of Fish.	Average.				Percentage.		
				Cod.	Codling.		Total.	Cod.	Codling.	
					I.	II.			I.	II.
		Fms.								
May	Aberdeen Bay -	9-16	50	2·4	0·6	0·02	3·0	78·0	20·0	2·0
	Moray Firth -	4½-30	341	0·8	2·1	1·7	4·6	18·5	44·3	37·2
	50-80 miles south-easterly of Shetlands.	58-76	1,036	1·0	19·4	0·3	20·7	4·7	93·8	1·5
June	Aberdeen Bay -	5-20	42	1·5	0·1	0·4	2·1	73·8	4·8	21·4
	Moray Firth -	6-36	102	1·3	2·4	0·6	4·3	31·4	55·9	12·7
	Fisher Bank -	34-37	131	1·4	0·9	1·2	3·6	39·7	26·0	34·3
	50-90 miles easterly from Buchan Ness	64-71	133	3·1	4·9	0·2	8·3	47·6	59·4	3·0
	Do. do.	76-81	640	2·4	19·8	0·5	22·9	10·8	86·9	2·3
Sept.	Aberdeen Bay -	8-12	85	0·4	0·9	7·2	8·5	4·7	10·6	84·7
	Moray Firth -	6-30	171	0·5	0·04	6·1	6·8	8·2	0·6	91·3
	65 miles S.E. of Sumburgh Head	65	209	0·8	6·1	0·0	6·9	11·0	88·5	0·0
Oct.	Aberdeen Bay -	5-20	746	0·5	23·3	2·6	26·4	1·8	88·2	9·9
	Moray Firth -	6-30	516	0·4	6·1	0·6	7·1	5·4	85·8	8·7
	18-22 miles S.E. of Fair Isle.	65	857	1·9	7·4	0·17	9·5	19·7	78·4	1·9

Examination of these figures shows the variations in the different areas at the times. Considering first the totals, it will be noticed that the average is highest on the offshore grounds with the exception of Aberdeen Bay in October. Cod were more numerous in the deep water in each of the months except May in Aberdeen Bay, and relatively more so in June in all the areas than in any of the other months. In September and October the average was the smallest in Aberdeen Bay and the Moray Firth, and it was low in the deep water. The averages show the absolute abundance, but the percentages, which show the relative numbers of the three classes, also indicate a preponderance of the adult fishes in June, compared with the other comparable months.

The second class, or large codlings, vary to a much greater extent. On the deep-water grounds the average was nearly always much higher in May and June than in September and October, being 19·4 for May, 19·8 for June, and 6·1 and 7·4 for the two latter months. In October the highest average of all was Aberdeen Bay with 23·3. The percentage of large codling was always high in the deep water, being 93·8 in May to 59·4 and 86·9 in June, 88·5 in September, and 78·4 in October. In Aberdeen Bay it was 20·0 in May, 10·6 in September, and 88·2 in October. In the Moray Firth it was 44·3 in May, 55·9 in June, 0·6 in September, and 85·8 in October. In the latter months the proportion in the inshore waters was thus high.

The variation in the abundance of the small unmarketable codling was also very marked. In all cases the average was least in the deep water hauls, ranging from 0·0 to 0·5 per hour's fishing, while in Aberdeen Bay the average ranged from 0·4 to 7·2, and in the Moray Firth from 0·6 to 6·1. The percentages also show a considerably greater proportion of young codlings near the coast. Thus while in the deep water the percentage to the older fishes was 1·5, 2·3, 3·0, 0·0, and 1·9, it was in Aberdeen Bay 2·0, 21·4, 84·7 (in September), and 9·9, and in the Moray Firth 37·2, 12·7, 91·3, and 8·7. On the Fisher Bank in June the percentage was 34·3.

These averages and percentages indicate that the cod in its younger stages—up to about two years of age—is not present in numbers at the bottom in the deep water, and that it is much more abundant near the coast.

In considering the three classes into which the cod is divided by the trawlers certain facts must be borne in mind. Those classed as cod and marketable codlings represent the numbers on the ground at the time, so far as can be determined by a trawl, that is to say none of them escape through the meshes of the net. The averages therefore truly indicate the numbers present, but there may be in some cases a slight variation due to the selection, *i.e.* a largish fish may be classed sometimes with the codlings and sometimes with the cod. For the purpose of determining the size-limits of the three classes I have tabulated my notes of measurement in a considerable number of cases. The lower limit of cod is usually about twenty-seven inches; occasionally one at twenty-six inches was included. The upper limit of marketable codlings was usually twenty-five inches; in a few instances I find twenty-six inches, and even twenty-six and a half and twenty-six and three-quarters. The division may, therefore, be placed at twenty-seven inches, which corresponds also with the approximate size at which the majority of cod become mature for the first time. The lower limit of marketable codlings ranges in different lots from ten and a half to twelve, and even twelve and a half and twelve and three-quarter inches, and the highest limit of the unmarketable from ten and a half to eleven and three-quarters and occasionally twelve inches. Eleven and a half inches may be taken to represent the division as a rule. The lower limit of the third class or unmarketable varied in different cases. Setting aside some instances in which a few of about six inches were caught, the majority of the smaller forms had a minimum size ranging from seven and a quarter to eight and a half and occasionally to nine inches. Considerable numbers of these smaller codlings must escape through the meshes of the net; the largest found in the fine-meshed net which had thus passed out had a size ranging from six and a half, up to eight, and occasionally to eight and three-quarter inches. The third class is thus imperfect, but may be taken as fairly representing the codlings between eight and a half or nine inches,

and eleven and a half inches. In the course of the investigations the number of cod and codlings recorded was 9631, grouped as follows:—

Codling. II. From about 8¼ or 9 inches to 11½ inches and under two years old.	Codling. I. From about 11½ inches to about 27 inches, and from under two to about four years old.	Cod. From about 27 inches upwards, and from about four years old upwards.
1,416	5,722	2,493
% 14·7	% 59·4	% 25·9

The first series of small codlings thus represents only a difference of about three inches from the smallest to the largest, and a correspondingly small range of age; the large codling represent a difference of about fifteen and a half inches, and the group of cod a range of usually about twelve or thirteen inches, but it may be much more.

Although very young cod, younger than those included in the Table, are not quite absent from the bottom on the offshore deep-water grounds, the use of the small-meshed net showed that they were rare, compared with the grounds in moderate depths. But, as Hjort's investigations have shown, they may exist in fair numbers in the upper layers of water, descending to the bottom as they increase in size. Compared with many other fishes, the cod at all stages of its life appears normally to be a widely-dispersed fish. I have been struck with this in examining the hauls on the trawlers, a few, and only a few, cod or codlings being generally taken in each drag. During the greater part of the year they are dispersed and scattered, searching for food, collecting into shoals as the spawning season approaches, and congregating in pursuit of the herrings when that fish forms into shoals at certain times of the year. The low proportion of cod and large codling in September, as indicated in the Table above, may have been due to the latter reason, and the high averages in the early part of the year on the inshore grounds largely to the former. The occurrence, however, of a shoal of herrings or sprats on the coast, as in the Moray Firth in December and Aberdeen Bay in October, attracts great numbers of cod of all sizes. Some of the quite small codlings were found to be gorged with sprats and young herrings, and they were also living largely on the young whitings.

Saithe or Coal-fish (*Gadus virens*).

Comparatively few of this predaceous fish were obtained during the investigations, and they were nearly all large and marketable, the younger forms being known to frequent the inshore grounds. The total number obtained was 266, of which all but ten were large enough to be marketable. Ten were got in the large series of hauls in Aberdeen Bay, mostly in summer; sixty-five in the Moray Firth, especially in January, February, and March; while on the deep-water grounds they were much more numerous, 185 being procured there in comparatively many fewer hauls. They were most numerous in the hauls made in May, off the Aberdeenshire coast, in from sixty-four to seventy-one fathoms, the average per haul there being 16·2, and per hour's fishing

4·1. They were also abundant in May, off Fair Isle, in sixty-five fathoms. None of the saithe got on the deep-water grounds were so small as to be unmarketable, all the latter being caught in the Moray Firth or Aberdeen Bay. The sizes on the deep-water grounds ranged usually from about twenty-five to thirty-five inches, but some thirty-eight inches in length were procured. The smallest measured $16\frac{1}{2}$ inches. The deepest water in which they were taken was in eighty-five fathoms, north-east of the Shetlands—which was the deepest haul made and the furthest north—but they extend further than this.

Very few of the young fishes were secured on board the trawlers, whether with the small-meshed net or the ordinary otter-trawl. In Aberdeen Bay in September, in from seven to nine fathoms, eight were taken in the fine net, measuring from 140 to 171 mm. ($5\frac{1}{2}$–$6\frac{3}{4}$ inches). In August in Burghead Bay, in a haul in from five to twenty fathoms, two measured 131 and 254 mm.; in November in Aberdeen Bay, in eleven to eighteen fathoms, one was taken 161 mm. in length. Smaller forms were procured by the "Garland" in shallow water in June, their length ranging from 24 mm. to 52 mm. (1–$2\frac{1}{8}$ inches), and in the push-net on the beach others were taken from 25 to 31 mm. In the Clyde, among the tangles near shore, a number of specimens, taken in September, ranged in size from 27 to 83 mm.

Young saithe under a variety of names are caught by hook and line, and in some places by nets, along the coast, the shore-loving habit of the young being more marked than in most other members of the genus, and in some respects comparable to that of the plaice. From the paucity of specimens in these trawling investigations alone, it would appear that they frequent more particularly the rocky margins. The fact that the older forms are found in such numbers in deep water far from shore is a proof of the extent of their migrations. Like the hake and cod they are not unfrequently taken in the herring seine-nets in the upper layers in places where the water is deep, and they no doubt roam freely in mid-water, particularly in pursuit of herrings, mackerel, and other fishes upon which they largely subsist.

Pollack or Lythe (*Gadus pollachius*).

Very few specimens of this species were obtained, viz. forty, and they were all got on three occasions. No less than twenty-eight were taken in the trawl in Aberdeen Bay, in from six to nine fathoms, on 9th November, all marketable. Other six, also marketable, were caught on 6th September in Spey Bay, Moray Firth, in from seven to nine fathoms, and other six, five in one haul and one in another haul, in sixty-five fathoms, south-east of Fair Isle, in October—and these were likewise marketable. The fish is not uncommon at the Shetlands and Orkneys, and occasionally the trawlers land small quantities from other places.

I give here in tabular form particulars regarding the pollack taken by the trawlers.

[Table.

Date.	Place.	Depth in Fms.	Quantity.
1901.			Cwts.
30 March -	About 60 miles W. of Ekersund, Norway.	40-50	14
8 April -	About 20 miles S.E. of Aberdeen ; 20 miles from coast.	40-50	¼
12 ,, -	About 75 miles E. of the North of Shetlands.	70 (?)	6
2 Sept. -	About 45 miles S.S.E. of Aberdeen; about 35 miles off coast of Kincardine.	46	2
1902.			
15 Feb. -	About 146 miles E. by N. of Aberdeen.	40-50	1
22 April -	About 10-12 miles off Loch Laxford.	.	2
23 ,, -	About 15-16 miles S.S.W. of Cape Wrath.	.	3
1 May -	The Minch.	.	2
12 ,, -	"Fisher Bank," about 175 miles E. from Aberdeen ; about 90 miles W. of Ekersund, Norway.	40-45	16
16 ,, -	"Fisher Bank," about 170 miles E. ½ N. of Aberdeen, and 90 miles from Ekersund.	40-45	1
21 ,, -	"Fisher Bank," about 200 miles E. ½ S. of Aberdeen ; 65 miles from Ekersund.	40-50	2
28 ,, -	"Fisher Bank," about 180 miles E. by S. ; about 90 miles W. of Naze.	35-45	2
7 June -	About 37 miles S.S.E. of Aberdeen ; 30 miles from coast.	30-40	½
10 ,, -	70 miles S.E. ; 50 miles off coast of Kincardine.	40-50	2
13 ,, -	50-60 miles S.S.E. ; about 50 miles E. of St. Abb's Head.	40-50	½
8 October	50 miles S.E. by S. ; 45 miles off coast of Kincardine.	36-38	¼
13 ,, -	230 miles E. ½ S. ; about 55 miles off Ekersund.	40-50	2
22 ,, -	27 miles E.S.E. ; about 30 miles off coast of Aberdeen.	30-40	½
27 ,, -	180 miles E. by S. ; about 90 miles W. of Ekersund.	35-37	1
6 Dec. -	170 miles E. by S. ; about 125 miles W. of Naze.	40	1½
12 ,, -	200 miles E. ; about 75 miles W. of Ekersund.	43-46	1

The facts are of interest. With the exception of those taken on the West Coast, and six cwts. taken to the east of the north of the Shetlands, all the pollack landed were caught in two localities—(1) on the eastern and northern part of the Great Fisher Bank, from about sixty to one hundred miles from the south-west coast of Norway, in from thirty-five to fifty fathoms, (2) off the east coast of Scotland, between Aberdeen and the Tay, at a distance from about twenty to sixty miles from the coast, and in from thirty to fifty fathoms (*see* Chart, Plate I.). The period in which they were taken was either the spring and early summer, from 15th February to 13th June—and mostly in April or May—or September, October, and December.

The spawning-period of the pollack was found by Holt to be from March to June on the west coast of Ireland, and Williamson obtained the floating eggs in Loch Fyne also in these months, but mostly in March.* On the East Coast ripe fishes were obtained at Shetland in May ;† while some authorities, as Dunn and the authors of the *Scandinavian Fishes*, believe that it spawns towards the end of winter. It appears highly probable, therefore, that the catches of the pollack on

* *Ibid.*

† *Tenth Ann. Rep., Part III.*, p. 288.

the two grounds mentioned were made during the spawning-season, and that the fishes had assembled in the comparatively deep water and at a considerable distance from shore for spawning purposes. The catches in autumn and winter are less easy to explain; but there are instances of a similar phenomenon with some other species.

In the Dornoch Firth, on 5th November, seven young pollack were taken in the small-meshed net around the cod-end of the otter-trawl. They measured from 128–169 mm. (5–$6\frac{7}{8}$ inches), the mean size being 149·7 mm. or $5\frac{7}{8}$ inches. In Kilbrennan Sound, in shallow water near shore, on 15th July four specimens were secured ranging from 53 to 61 mm. ($2\frac{1}{8}$–$2\frac{3}{8}$ inches). These sizes agree with a spring-spawning; and as the young fishes are found in numbers in the rock pools and zostera-beds in autumn, it is evident that they must cover, at some stage, a considerable distance in their shoreward migration if the spawning areas are situated as far from shore as the above facts indicate.

Ling (*Molua molva*).

Only 281 specimens of this species were procured, of which 252 were obtained in the comparatively few hauls in the deeper water, especially off Fair Isle, in sixty-five fathoms, in October, when as many as sixty-eight were taken in one haul, other hauls yielding thirty-two and twenty-six. It was much less common further south. A few were taken in the Moray Firth, especially in autumn and winter, and in the deep "Dog Hole," off Aberdeen, fourteen were procured, the haul in June for one hour and five minutes yielding seven. The range of size of the adults on the deep-water grounds is generally from three to four feet; the largest measured there was fifty-eight inches and the smallest fifteen inches.

Only four of the aggregate number were too small to be marketable, one off Aberdeen Bay in October, which measured eleven-and-a-half inches, and was got in water from thirty-six to forty-nine fathoms deep; the other three were taken in the deep water, one of them in eighty fathoms.

The trawlers get more ling than cod in the deep water east and north-east of the Shetlands, but the proportion diminishes towards the shore, and also southwards in the North Sea. Two were taken in the nine hauls on the Fisher Bank in May.

Hake (*Merluccius vulgaris*).

The number of hake taken was also comparatively small, comprising altogether 440 specimens. Of these a few were got in Aberdeen Bay, mostly in summer; forty-nine in the Moray Firth, of which twenty-two were caught in a single haul in fifty fathoms about twelve miles from land in November; most of the others were got in August and July. The greater number, viz. 373, were procured on the deep-water grounds, and more particularly in the series of hauls south-east of Fair Isle, in sixty-five fathoms, in October, where ling were also most abundant. Here 339 were taken, the largest numbers in individual hauls being forty-five, forty-two, thirty-five, and thirty-four, and some were got in all the hauls but one, the average number caught per hour's fishing being 3·7.

The catches on this ground were, indeed, somewhat peculiar, inasmuch as they included large numbers of hake, saithe, ling, and sharp-nosed rays, as well as many picked dog-fish, several lythe, Norway haddocks, and argentines—some more characteristic of grounds in the

west of Scotland. An examination of the chart shows that the deep water, *i.e.* under a hundred and above fifty fathoms, extends westwards between the south point of the Shetlands and Fair Isle, as a submarine valley, the locality where the hauls were made being only eighty miles from the 100-fathom line to the west. It is thus not improbable that the *facies* of the fish-fauna in the region in question is connected with the course of the current that is known to run eastwards between Fair Isle and Shetland, in the same way as Cunningham has shown the fauna along the Dutch coast resembles in some respects that of the English Channel.

All the hake except five were of marketable size. The general range of the adults was found to be from thirty-three to thirty-eight inches, some were taken over forty-two inches in length, very few were under twenty inches. One nearly twelve inches in length (300 mm.) was taken in the deep water in October, and another of 222 mm. ($8\frac{3}{4}$ inches) in the Moray Firth, also in October. No small hake were taken in the fine-meshed net around the otter-trawl, but on one occasion 131 were taken in the Clyde in the shrimp-net of the "Garland, viz. in thirty-five fathoms in the channel midway between the south point of Arran and the coast of Ayrshire, on 15th December. The bulk measured from 55 mm. ($2\frac{3}{16}$ inches) to 123 mm. ($4\frac{3}{4}$ inches), and one was 141 mm ($5\frac{9}{8}$ inches). With the exception of the last mentioned, they formed a well-defined group, the average or mean length of the fish being 83·2 mm. or $3\frac{1}{4}$ inches, and they were, I presume, the brood of the year. According to Holt's observations on the west coast of Ireland, the hake spawns from the end of March until July, and in Loch Fyne Dr. Williamson found the eggs of the hake in April, June, July, and the first week in August.* If the fish which measured 141 mm. were included in the series, the intervening sizes being regarded as missing, the mean-size would be raised to about 98 mm. or $3\frac{7}{8}$ inches. One of these little hake, 114 mm. long, had in its stomach a goby which measured 50 mm.—a fact which illustrates the early assumption of the piscivorous propensity of the species.

The trawlers land considerable quantities of hake, mostly from the West Coast and from the region above indicated in the neighbourhood of Fair Isle. Comparatively few come from the waters adjoining the East Coast, but the fish is said to be more abundant on the Danish side. No hake were obtained in the nine hauls on the Fisher Bank at the end of May or beginning of June.

Tusk (*Brosmius brosme*).

Of this, the most typically deep-sea form included in the produce of the trawl fishery, only seventy-four specimens were caught, and all of them were taken on the deep-sea grounds, off the Fair Isle, and east-north-east and south-east and south of the Shetlands. None were taken on the Fisher Bank. Steam-liners, which fish further north and north-west in deeper water than the trawlers, land proportionally much larger quantities. All those obtained were marketable except two; one of them measured twelve-and-a-half inches. The general range of size is from about eighteen to twenty-eight inches; some measured thirty-nine inches.

Cat-fish (*Anarrhichas lupus*).

Of this species 299 specimens were procured, of which 96 were taken in the deep water on the north-eastern grounds, thirty-two on the

* *Seventeenth Ann. Rep. Fish. Board for Scotland, Part III.*, p. 96.

Great Fisher Bank, one in Aberdeen Bay, two in Thurso Bay, one in the Dog Hole off Aberdeen, and 167 in the Moray Firth. The facts concerning this uncouth and odd form are of some interest. With certain exceptions referred to below, usually only one or two or a few were taken in the same haul; it is thus evidently widely dispersed and scattered. The one taken in Aberdeen Bay was caught on 6th June in from five to sixteen fathoms, and it was marketable. The specimen procured at the Dog Hole, ten miles from Aberdeen, was got in fifty-eight fathoms on 21st August, and it was marketable. Another large specimen was obtained in the deep water—eighty-five fathoms—about eight miles from Kinnaird Head on 4th July.

On the Fisher Bank in thirty-four fathoms at the end of May and the beginning of June they were comparatively abundant, thirty-two specimens being taken in twelve hauls; three hauls were blank, but in the others cat-fish were obtained in numbers ranging from one to six, and they were all large. They were much commoner here than in the deeper water further north-west, off the coast of Aberdeen, immediately afterwards, where fourteen hauls in from sixty-four to eighty-one fathoms furnished only four. The bottom, however, was for the most part muddy. South-east and east of Sumburgh Head in the latter part of May they were numerous, fourteen hauls yielding fifty-six, of which all were marketable but three; the depth varied from fifty-eight to seventy-six fathoms, and twelve, eight, four, eight, and nine cat-fishes were taken in successive hauls. In September two were taken in nearly the same locality in four hauls. In October off Fair Isle, in sixty-five fathoms, eleven were taken, one of which was too small to be marketable; and in May in sixty-five fathoms, east of the Shetlands, twenty-three were taken, thirteen in one haul.

The particulars regarding the occurrence of the cat-fish in the Moray Firth are of interest. In the numerous hauls in the months of September, October, and November, comprising over 200 hours' actual trawling at various places and different depths, not a single cat-fish was taken. In August one was caught in Burghead Bay, in five to twenty-five fathoms; in July three, two in from seven to twelve fathoms in the place named, and one in eighty-five fathoms off Kinnaird Head; in June two, one in from five to fourteen fathoms in Burghead Bay, and one on Smith Bank in twenty-five fathoms. In summer and autumn, therefore, the cat-fish appears to be rare in the Moray Firth. In December, however, eighteen were taken; in January, with many fewer hauls, seven; in February ten, in March fifty-three, and in May seventy-five. Many of these were taken in comparatively shallow water, as in Dornoch Firth. There thus appears to be a migration of the large cat-fishes from the deeper water shorewards in winter and spring for spawning. The ovaries were not examined in these instances, little time having been available, but in April they were found to be spent, some of them having a few large ripe eggs which had failed to be expelled.

The number of unmarketable cat-fishes taken was small— and those of fourteen or fifteen inches fall into this category—being only seven. Very much smaller specimens would be retained by the otter-trawl net, and the explanation of their absence is no doubt the same as in so many other instances, viz. their absence from the bottoms where the trawl can work.

The most disadvantageous attribute of a fish in the sea is diminutiveness; the smaller it is the more it is liable to be swallowed by others; as it increases in size the number of its possible enemies diminishes and its chance of survival is greater. Security may be sought in some cases by a pelagic habit, but in many instances it is obtained by frequenting rocky bottoms covered with algæ, and on these

the trawl cannot work. The young cat-fish is probably to be found mostly in such quarters.

Herring (*Clupea harengus*).

From its size the herring, as a rule, is not retained in the trawl-net, although from the experiments with the fine-meshed net it is certain that they frequently enter the otter-trawl. In the course of the investigations herrings were taken in thirty hauls, the numbers varying from one to as many as eighty-eight, fifty-one, and forty-four. On two occasions they were taken on the north-eastern grounds, namely in September in sixty-five fathoms, and in October in sixty-six fathoms. In Aberdeen Bay they were caught in May, June, July, and December, the depths of the water in which the hauls were made being from four-and-a-half to sixteen fathoms. In the Moray Firth they were taken in the Dornoch Firth in July, November, and December, the hauls being made in water from six to thirteen fathoms; off Dunbeath in January in twenty-four fathoms; and in or near Burghead Bay in May, July, December, and January, the depths ranging from seven to twenty-four fathoms. Young herrings, from three to seven or eight inches in length, were frequently taken in the small-meshed net outside the otter-trawl, as many occasionally as nearly two thousand in an hour's drag. The particulars in regard to those caught in the otter-trawl are appended :—

Date.	Place.	Depth in Fms.	No.
4 Sept.	65 miles S.E. of Sumburgh Head	65	5-7
19 October	18 ,, S.E. of Fair Isle	66	2
6 Nov.	Dornoch Firth	8-10	51
6 ,,	Do.	8-10	6
17 Dec.	Aberdeen Bay	9-15	5
18 ,,	Do.	8 10	1
18 ,,	Do.	7-9	1
25 ,,	Dornoch Firth	12	8
30 May	Aberdeen Bay	12-16	5
30 ,,	Do.	9-14	1
6 June	Do.	4½-16	1
6 ,,	Do.	15-16	4
1 July	Burghead Bay	7-15	1
2 ,,	Do.	7-10	2
2 ,,	Dornoch Firth	10	1
3 ,,	Do.	10-12	9
5 ,,	Aberdeen Bay	8-15	88
5 ,,	Do.	8-12	10
31 ,,	Do.	8-12	1

Date.	Place.	Depth in F'ms.	No.
9 Nov. -	Dornoch Firth - - - - - - - -	7–10	1
9 ,, -	Do. - - - - - - - -	9–13	1
11 ,, -	Do. - - - - - - - -	9–13	3
19 Dec. -	Do. - - - - - - - -	6–10	3
19 ,, -	Do. - - - - - - - -	9–10	19
20 ,, -	Burghead Bay - - - - - - - -	7–24	44
24 ,, -	Do. - - - - - - - -	10	15
24 ,, -	Do. - - - - - - - -	10	1
17 Jan. -	Off Dunbeath - - - - - - - -	24	4
18 ,, -	Burghead Bay - - - - - - - -	7½–22	5

Herrings are sometimes landed in considerable quantities by trawlers, and as they are always large they command a good price. They are mostly taken in September, October, and November, and over a ton is sometimes brought to port by one trawler. They get them sometimes near the coast, but more commonly out towards the middle of the North Sea, as the Great Fisher Bank, and on the north-eastern grounds in deep water. From the following particulars of catches last year, it will be seen that in September they were caught mostly from 150–180 miles E.S.E. from Aberdeen, on the western part of the Great Fisher Bank, in from thirty to forty fathoms. They were also got there in November, but in October they came from further north, midway between the Orkneys and Norway, and at greater depths.

Date.	Place.	Depth in Fathoms.	Cwts.
1 Sept. -	18 miles E. by N.; about 13 miles off coast of Aberdeen.	30-40	24
10 ,, -	180 miles E.S.E.; Great Fisher Bank - . -	30-40	2½
17 ,, -	155 ,, ,, ,, - - -	40-45	22
18 ,, -	150 ,, ,, ,, - - -	40	4
19 ,, -	180 ,, ,, ,, - - -	30-40	4½
1 October	150 miles N.E. by E. ½ E. - - - - .	.	5
1 ,, -	150 miles N.E. by E. - - - - - -	.	2
8 ,, -	160 miles E.N.E. - - - - - - -	.	¾
15 ,, -	140 miles N.E. by E. - - - - - -	.	1½
19 Nov. -	140 miles E.S.E.; W. of Fisher Bank - - -	40-50	1
25 ,, -	140-160 miles E.S.E.; ,, ,, - -	37-38	1½

Sprat (*Clupea sprattus*).

Sprats were occasionally taken in the otter-trawl and not unfrequently in the small-meshed net—sometimes many hundreds of them. They occurred in the otter-net on the following occasions—viz., in June and July in the Dornoch Firth and Aberdeen Bay, in the Dornoch Firth in December, and at the Dog Hole off Aberdeen and off Dunbeath in December, as shown in the following Table :—

Date.	Place.	Depth in Fms.	No.
6 June, - -	Aberdeen Bay, - - - - -	4½-16	2
2 July, . -	Dornoch Firth, - - - - -	10	1
3 , - -	,, ,, - - - - -	10-12	23
3 ,, - -	,, ,, - - - - -	,,	2
3 ,, - -	,, ,, - - - - -	6½-12	3
5 ,, - -	Aberdeen Bay, - - - - -	8-15	1
19 December, -	Dornoch Firth, - - - - -	9-10	3
15 January, -	Dog Hole, off Aberdeen, - - - -	57	1
17 ,, -	Off Dunbeath, - - - - - -	24	1

Sprats were never taken in either the otter-net or the fine net on the offshore grounds, but a few were obtained in hauls at the Dog Hole in deep water—viz., on 28th November fourteen, measuring from 87–125 mm. ($3\frac{1}{2}$–$4\frac{15}{16}$ inches)—on this occasion three anchovies were also caught,—and on 15th January, when other fourteen were taken. None were taken at the Dog Hole in June, July, August, or December. In Aberdeen Bay sprats were captured in January, June, September, October, November, and December, in hauls made in from five to eighteen fathoms. At Lunan Bay, Montrose, eighty were taken on 28th June in a drag of sixteen minutes, along with 1916 herrings, the depth being about twelve-and-a-half fathoms. In the Dornoch Firth two were taken in July in ten to twelve fathoms, and 185 in December; at Burghead Bay in December, in the Firth of Forth in May, and in the Cromarty Firth in January and June. The haul on 1st June in the Cromarty Firth was of interest, because it was found that the larger sprats, of which 552 were taken, ranging from 73 to 124 mm. ($2\frac{7}{8}$ to $4\frac{7}{8}$ inches) were spawning. Females from 104 mm. upwards were ripe, and males from the same size; but some may have been mature under the length given. The temperature of the bottom was 55° F., and of the surface water 54°·7. The small-meshed net also contained seventy young herrings ranging from 104 to 197 mm., seventy-seven small whitings from 132–195 mm., which were feeding on the young sprats and herrings; three codlings from 143 to 152 mm., similarly engaged; and a fifteen-spined stickleback, 153 mm. in length, from which the ripe eggs were extruding.

[Table.

Date.	Place.	Depth.	No.	Size.
10 January ...	Cromarty Firth	6½-7	27	61–117mm.
15 ,, ...	Dog Hole (off Aberdeen) ...	57	14	—
15 ,, ...	Aberdeen Bay	7–16	1	—
13 May ...	Firth of Forth—Station III. ...	...	568	52–134 ,,
1 June ...	Cromarty Firth	8	552	73–124 ,,
13 ,, ...	Aberdeen Bay	5–12	58	86–116 ,,
28 ,, ...	Lunan Bay, Montrose	12½	80	86–117 ,,
2 July ...	Dornoch Firth	10–12	2	—
4 September .	Aberdeen Bay	10	1	—
18 October ...	Do.	8–16	108	82–139 ,,
28 November...	Dog Hole	68	14	87–125 ,,
29 ,, ...	Aberdeen Bay	11–18	1	—
17 December...	Do.	9–15	26	66–132 ,,
19 ,, ...	Do.	6–8½	74	67–111 ,,
25 ,, ...	Dornoch Firth	10	185	72–130 ,,
25 ,, ...	Burghead Bay	7½–18	536	—

Mackerel (*Scomber scombrus*).

Very rarely were mackerel taken in the trawl-net. In October, off Dunbeath, Caithness, one was caught in twenty-four fathoms. At certain times, however, they are taken in some numbers by the trawlers and landed at Aberdeen. Last year, for example, the quantities (in cwts.) landed, so far as ascertained, were as follows:—

Jan.	Feb.	Mar.	Sept.	Nov.	Dec.	Total.
11¾	1½	8	1	4	17⅞	44⅛

Thus they were taken chiefly in December and January, and none were procured from March to September. With scarcely an exception they were caught north-east to east by north of Aberdeen at distances of from about forty-five to 130 miles from the nearest coast. Most were taken south-easterly of Fair Isle. It is noteworthy that those got in September and November were taken further south, in the region of the Great Fisher Bank, usually along with herrings; in December they were further north and west, on the edge of the deep water, and to the north-west in deep water, south-east of the Shetlands; in January, further west opposite the mouth of the Moray Firth; in February, about fifty miles south-east of Fair Isle; while in March the single quantity taken was got far north in about Lat. 60° 5′ N., nearly midway between Norway and the Shetlands. The data are too slender to theorise upon; but the idea might be entertained, so far as these facts go, that the shoals were moving north and west as if making their way to the Atlantic, mostly between the Orkneys and the Shetlands. On the other hand, the mackerel may have been present in numbers at other times or other places, but in the

surface waters—their usual habitat—the trawlers' catches simply indicating that at the times and places described they were feeding at the bottom, having withdrawn in the winter to deeper water. The mackerel, which in summer and autumn are found along the coasts, then usually desert them, and probably move out into deeper water and frequent the bottom—that is to say, they seek the layers of water where the highest temperature prevails. In many cases the depths at the places where they were caught exceeded seventy fathoms. I think it improbable that they were taken in the surface waters while the net was being shot or hauled: first, because of the large numbers obtained in some instances; second, because the net in either process is not dragged rapidly through the water and the mackerel is a swift and agile fish; and third, because herrings have been taken from the bottom in similar depths, proved also by their presence in a semi-digested condition in the stomachs of anglers. None were got, as stated, in the early summer, when the spawning shoals are in the surface waters and near the coast. I append the particulars of each catch; when the depth is inserted in brackets it means that it has been derived from the chart. Otherwise it is the depth stated by the trawler. The positions where they were taken are indicated in the chart (Plate I.) as M 1, M 2, &c.

No.	Date.	Place.	Depth.	Quantity.
			Fathoms.	Cwts.
1	14 Jan.	64 miles N.E. by E.; about 25 miles E. by N. of Kinnard Head.	[60-68]	1
2	17 ,,	100 miles E.N.E.; about 60 miles E. by N. of Kinnard Head.	[75]	2
3	21 ,,	130 miles N.E. by E.; about 100 miles E. by N. of Kinnard Head.	[70]	¾
4	27 ,,	90 miles N.E.; about 65 miles E. by N. of Kinnard Head.	[65-70]	4
5	27 ,,	40 miles S.E. from Out Skerries	[70]	4
6	12 Feb.	126 miles N.E. ½ N.; about 40 miles S.E. of Fair Isle.	[70-80]	½
7	24 ,,	150 miles N.E.; about 50 miles S.E. by E. of Fair Isle.	[60-70]	1
8	12 March	230 miles N.E. by E.; about 80 miles W. of Norwegian coast, at Bergen.	[60-70]	8
9	19 Sept.	180 miles E.S.E.; Great Fisher Bank	[34-38]	1
10	17 Nov.	210 ,, ,, ,,	[30-40]	½
11	25 ,,	140-160 ,, ,, ,,	37-38	3½
12	5 Dec.	180 miles N.E. by E.; midway between Fair Isle and Norway.	65-68	7¼
13	13 ,,	150 miles E. by N.; midway between Aberdeen coast and Norway.	45-50	2¼
14	15 ,,	150 miles E. by N.; midway between Aberdeen coast and Norway.	45-50	1
15	16 ,,	105 miles E. from Aberdeen	54-57	¼
16	24 ,,	150 miles N.E. by E.	68	7
17	25 ,,	80 miles E. by N.	70	⅛

Lesser Weever (*Trachinus vipera*).

This species was very rarely taken in the small-meshed net on the East Coast, but on two occasions considerable numbers were secured. On 5th July, in Aberdeen Bay, in ten fathoms, off Collieston, forty-seven

were taken, seventeen being females, measuring from 113 mm. to 132 mm. ($4\frac{1}{2}$–$5\frac{3}{16}$ inches), and thirty males, from 93 mm. to 135 mm. ($3\frac{11}{16}$–$5\frac{5}{16}$ inches). The average size of the females was 120·4 mm. or $4\frac{3}{4}$ inches, and of the males 111·7 mm. or $4\frac{3}{8}$ inches. They were ripe and spawning. On 31st July a haul for forty-five minutes, in from eleven to thirteen fathoms, opposite the mouth of the Ythan in Aberdeen Bay, gave eighty-two specimens, viz. fifteen females and sixty-seven males.

These fish were spawning, ripe eggs and spermatic fluid oozing on touching them, and it was thus a simple matter to determine the sex.

On 4th September, off Newburgh, Aberdeen Bay, in ten fathoms, one, 135 mm. long, was taken, the sex of which was not determined; on the same day, two females, 118 and 127 mm., both spent.

The smallest ripe female in July measured 110 mm. ($4\frac{3}{8}$ inches), the next being 113 mm., and the largest was 161 mm. ($6\frac{3}{8}$ inches). The smallest ripe male measured 91 mm. or $3\frac{9}{16}$ inches, and the largest 138 mm. ($5\frac{7}{16}$ inches). Forty-one of the males were under the size of the smallest female, and fifty under the size of the second smallest. The excess of males is contrary to the rule among fishes producing pelagic eggs, the only exception previously stated being in the case of the flounder;* but it is perhaps questionable whether the figures mentioned really represent the true proportions in numbers between the sexes. The lesser weever, as was known to Parnell,† is extremely common in the Solway, and I find from the examination of 124 specimens from there that the females were slightly in excess, viz. 64 to 60 males. They were taken in April, May, August, September, October, and November, none being secured in June and July, when they had probably migrated into deeper water to spawn. It is pretty certain from the disparity in the sizes of the males and females that the former attain maturity at an earlier age than the latter, and the great excess of the ripe males in Aberdeen Bay probably indicates that a younger generation of them took part in reproduction, the females of corresponding age being still immature and thus not migrating out to spawn with the others. In any case, however, the excess of females, if there be excess, cannot be great, the small preponderance in the samples from the Solway being very much less than among other species producing pelagic eggs.‡ It is interesting to note that the flounder and the lesser weever are the two fishes with pelagic eggs in which the females do not greatly preponderate, or may be indeed less numerous than the males. Both spawn near shore in water of moderate depth, migrating from the shallower water to do so. The proportion of the sexes in the sprat, which also spawns inshore in summer, has not apparently been determined. Among the weevers from the Solway in April, September, August, and November, the average size of the females was 107·2 mm. or $4\frac{1}{4}$ inches, and of the males 90·3 mm. or a little over $3\frac{1}{2}$ inches.

The lesser weever seems to spawn later than the majority of fishes. Day says vaguely it spawns in spring; Brook gives April, May, and June as the period on the coast of Yorkshire,§ and he found those kept in his tanks spawned in June and July;‖ M'Intosh states that the floating eggs are found in St. Andrews Bay in April, May, and June;¶ and Holt found a female "nearly ripe" in May on the Irish coast, and the floating eggs in considerable abundance in June and

* *Tenth Ann. Rep., Part III.*, p. 239.
† Fishes of the Firth of Forth, p. 173.
‡ *Fourth Ann. Rep. Loc. cit.*
§ *Tenth Ann. Rep., Part III.*, p. 244.
‖ *Journ. Linn. Soc.*, xviii., p. 274.
¶ *Ninth Ann. Rep., Part III.*, p. 326.

July;* while Williamson procured the eggs in small numbers in Loch Fyne on 14th May, 9th and 10th June, and 6th July, but found none in April.† Ripe females have been procured by myself at the end of June at Dunbar, and, as above described, in Aberdeen Bay at the beginning and end of July. A female, 102 mm. in length, was approaching ripeness on 18th June, in the Dornoch Firth, the ovarian eggs measuring 0·5 mm. In the Solway, on 24th May, females of 94, 95, 98, and 117 mm. were approaching ripeness, and males from 82 mm. to 102 mm. were in a similar condition. It is thus probable that the spawning takes place mostly in June and July. The occurrence of floating eggs in our waters in April is probably exceptional.

Information bearing upon the rate of growth of the lesser weever is not extensive. Brook found that hatching occurred in from nine to eleven days. A specimen measuring 15 mm. was taken by the "Garland" probably in autumn,‡ but the date is uncertain. On 18th June an example, 33 mm. ($1\frac{5}{16}$ inches) in length, was taken in the Dornoch Firth by the "Garland," and M'Intosh mentions another measuring 45 mm. ($1\frac{3}{4}$ inches) caught in July. These specimens were doubtless about one year old. The next smallest which has come under my observation was a female that measured 63 mm. ($2\frac{1}{2}$ inches), and was taken in the Solway on 30th April. It is fairly certain, I think, that this was not a fish of the preceding year, but was approaching two years of age. Apart from various other considerations, the fact that the lesser weever does not reach the same size in the Solway as on the East Coast—a circumstance, as I have elsewhere shown, which is also true of the plaice and the common dab, and in the Clyde of the long rough dab§—while the smaller specimens were got later on the East Coast, goes against the supposition. The specimens next in size from the Solway were a female measuring 71 mm. on 21st September, one measuring 74 mm. on 30th April, and two males on 26th October, one measuring 70 mm. and the other 72 mm. As already stated, no ripe individuals were procured from the Solway, but on 24th April the female of 63 mm. ($2\frac{1}{2}$ inches) alluded to above had eggs a few of which measured 0·11 mm.; another, of 74 mm., had eggs up to 0·13 mm.; one of 106 mm., eggs up to 0·13 mm.; while in one of 113 mm. and one of 112 mm., the largest eggs measured 0·15 mm. On 24th May, in a female of 117 mm., the eggs measured 0·33 mm., and in one of 98 mm. nearly the same; two of 94 and 95 mm. were approaching ripeness. It is therefore probable that these individuals would have spawned in the ensuing season, when some of them would be under or little over 80 mm. in length.

In Aberdeen Bay, as stated above, the smallest ripe female measured 110 mm., and the smallest ripe male 91 mm.

I give below a Table in which the specimens obtained at different times are grouped in three-millimetre groups. The difference in size between the Aberdeen Bay and Solway Firth is obvious, and in several instances at least three annual groups appear to be represented. While it is not possible to fix definite limits to the various series, the probability is that the males reach maturity when two and the females when three years of age:—

* *Rep. of Council, Roy. Dubl. Soc.*, for 1891, p. 246; *Sci. Trans. Roy. Dubl. Soc.*, iv. ser. ii., p. 437.

† *Seventeenth Ann. Rep., Part III.*, p. 83.

‡ *Ninth Ann. Rep., Part III.*, p. 325.

§ *Twentieth Ann. Rep., Part III.*, pp. 346, 371, 385.

		59	61	64	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109	112	115	118	121	124	127	130	133	136	139	142	145	148	151	154	157	160	163
I. Aberdeen Bay.																																					
5 July, .	♀	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	1	1	3	2	3	1	...	...	...	...	...	...	...	...	...	...	...
	♂	...	...	...	...	...	...	...	...	...	...	...	2	...	2	3	4	4	3	1	1	2	3	1	3	...	1	...	...	...	...	..	...	...	...	...	...
Total, . .		...	...	...	...	...	...	...	...	...	...	...	2	...	2	3	4	4	3	7	2	3	6	3	6	1	1	...	...	...	...	...	...	...	...	...	..
31 July, .	♀	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	2	2	1	2	...	...	1	...	1	...	2	...	...	...	...	1	...
	♂	...	...	...	...	...	...	...	...	...	...	...	2	3	5	1	5	8	4	9	8	3	1	3	8	4	...	3	...	...	...	...	...	...	...	...	...
Total, . .		...	...	...	...	...	...	...	...	...	...	...	2	3	5	1	5	8	5	11	10	5	2	5	8	4	1	3	1	...	2	...	..	...	...	1	...
II. Solway.																																					
14 March, ♀+♂		...	...	...	...	...	...	...	...	...	...	1	2	...	1	1	...	...	1	1	...	...	...	...	2	...	...	...	...	1	...	...	...	...	...	...	...
30 April, .	♀	..	1	...	...	...	1	...	...	...	...	...	..	...	...	...	...	1	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	♂	...	...	...	...	...	...	...	2	3	1	...	...	1	...	1	...	...	...	...	1	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total, . .		...	1	...	...	...	1	...	2	3	1	...	...	1	...	1	...	1	...	3	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24 May, .	♀	...	...	...	...	...	...	...	...	...	...	...	...	2	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	♂	...	...	...	...	...	...	...	...	1	...	1	1	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total, . .		...	...	...	...	...	...	...	...	1	...	1	1	2	2	2	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

	59	61	64	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109	112	115	118	121	124	127	130	133	136	139	142	145	148	151	154	157	160	163
SOLWAY—*contd.*																																				
1 August, ♀	...	...	...	...	...	...	...	1	...	...	1	...	...	1	2	1	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
♂	...	...	...	...	...	...	1	1	2	1	3	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	—	...
Total, . .	...	...	...	...	...	...	1	2	2	1	4	...	...	1	2	1	...	...	1	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
14 Aug., ♀ + ♂	...	...	...	...	...	...	2	7	7	14	16	14	13	6	4	7	4	2	2	1	1	...	3	...	1	1	...	...	...	...	...	...	...	...	...	...
21 September, ♀	...	...	...	...	1	...	...	...	...	1	1	2	1	1	2	1	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...
♂	...	...	...	...	...	...	...	...	...	...	...	2	1	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total, . .	...	...	...	...	1	...	...	...	...	1	1	4	2	2	4	1	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...
27 September, ♀	...	...	...	...	...	1	...	2	...	...	1	1	3	1	3	...	1	3	3	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
♂	...	...	...	...	...	1	1	...	2	4	1	2	..	...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total, . .	...	...	...	...	...	2	1	2	2	4	2	3	3	1	4	...	2	3	4	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
26 October, .	...	...	...	...	2	...	...	1	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27 November, ♀	...	...	...	...	...	...	...	...	...	...	1	1	1	...	1	...	2	1	1	1	1	...	...	1	...	1	1	...	...	...	...	...	...	...	...	...
♂	...	...	...	...	...	...	...	...	4	...	1	1	1	1	2	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total, . .	...	...	...	...	...	...	...	...	4	...	2	2	2	1	3	...	2	2	1	1	1	...	...	1	...	1	1	...	...	...	...	...	...	...	...	...

The Pogge or Armed-Bullhead (*Agonus cataphractus*).

Notwithstanding its small size specimens of this species were occasionally taken in the otter-trawl, their capture being doubtless facilitated by their form. Forty-six were taken by the ordinary net in the Moray Firth in January, June, July, October, November, and December, at Burghead Bay, in the Dornoch Firth, near Smith Bank, and particularly off the coast of Caithness. It was also got in Aberdeen Bay in January, June, September, October, November, and December. It was most common in the winter months; of 123 specimens seventeen were taken in October, forty-three in November, twenty in December, and thirty-one in January. With regard to its bathymetrical distribution, while it is abundant in sandy shallows, as in the Solway and in estuaries,* it is sometimes found in deeper water than is generally supposed. In Aberdeen Bay and the Moray Firth the common range of depth in which the hauls were made was from seven to twelve or fifteen fathoms. Off Dunbeath and Lybster, Caithness, it was taken in many hauls in from twenty-two to twenty-seven fathoms, five hauls, with the ordinary net yielding seventeen specimens. One was taken near Smith Bank in 31½ fathoms in June. In the depression off Aberdeen known as the Dog Hole specimens were occasionally taken in the small-meshed net. One was got in 58 fathoms in August, another in seventy fathoms, 12¾ miles from shore, in November; another in sixty-eight fathoms, also in November; another in fifty-seven fathoms in December, and two in fifty-seven fathoms in January. One 104 mm. in length was taken in May twenty-two miles east of Flugga, at the north of the Shetlands, in eighty-five fathoms. During the trawling investigations of the "Garland" in the Moray Firth twenty-eight specimens were caught in 308 hauls, and all except five were obtained at the outer stations in moderately deep water.

They were on the other hand found to be very abundant sometimes in the shrimp-net in the Solway Firth, and were occasionally also taken in the push-net on the beach in Loch Fyne and Aberdeen Bay.

A considerable number were examined and measured in order to determine the proportions in number and size of the sexes, the rate of growth, the size when maturity is reached, and the period of spawning. Setting aside a few lots in which the sexes were not completely separated throughout, the result shows 467 females and 398 males, the average size being 88·0 mm. for the females and 86·1 mm. for the males. The excess of females is considerable, that sex amounting to fifty-four per cent. of the total, and the males to nearly forty-six per cent.; but in several cases, as in November and March, males were in excess. The greatest disproportion was in October, when 118 females and 74 males were taken, and in December, when the females numbered 127 and the males 90. It is an exception to what appears to be a general rule that in fishes with demersal eggs the males are most numerous. The mean lengths—taking all sizes together—differ very little, viz. by 1·9 mm.

With regard to the period of reproduction, in a number examined on August 1st one large female 122 mm. (4¾ inches) long had a few large ripe eggs, but the majority were small, as was the case in the other specimens. On 27th September the eggs were small; in a female of 90 mm. the largest measured 0·3 mm.; one at 56 mm. had eggs up to nearly 0·1 mm., and in a female of 53 mm. the largest measured

* On one occasion a specimen from the Firth of Forth which I placed in fresh water lived in it for eighteen hours. *Vide Ninth Ann. Rep., Part III.*, p. 250.

0·06 mm. On 31st October a number of fishes were examined, with the following result:—

Length (mm.)	57	62	63	82	85	90	94	96	97	105	107	110	112	117	120
Diameter of largest Eggs (mm.) -	·15	·13	·13	·35	·35	·39	·39	·44	·5	·49	·45	·61	·66	·5	·64

In the portion of the ovary examined of the specimen at 112 mm. a single egg measuring 1·1 mm. was discovered, and in the one at120 mm., another measuring 1·13 mm. Since the fully ripe ovarian egg measures 1·8 mm., these specimens evidently indicated the approach of the spawning season. On 27th November the following measurements were made:—

Length (mm.)	47	53	66	70	81	85	90	100	110
Diameter of largest Eggs (mm.) -	·08	·1	·15	·19	·41	·41	·44	·56	·49

In the eggs of ·1 mm. and upwards the yolk was fully formed, but the ovaries were small. Larger eggs may have been present in some cases, but they were not observed. On 30th December a considerable number were examined, as given in the Table below, and the larger females were found to contain ripe or nearly ripe eggs. Females as small as 78 mm. ($3\frac{1}{8}$ inches) would obviously spawn in the ensuing season, but in such specimens both the ovaries and the eggs were much smaller, the latter measuring from 1·1 to 1·3 mm. Occasionally a large fish had also the smaller eggs. The smaller females had eggs up to 0·17 mm., and clearly belonged to another series; some at 60 and 61 mm. had yolked eggs of 0·12 mm., and others at 52 mm. and 53 mm. eggs also yolked measuring 0·1 mm. Many of the males at 70 mm. and under had well-developed testes, white and soft; in one at 59 mm. they were quite minute. On 14th March a number were examined. One female of 106 mm. contained nearly ripe eggs, measuring 1·3 mm.; one of 120 mm. was spent, with two or three large eggs retained; others of 98, 95, 96, and 97 mm. were spent, and others of 86, 89, 92, 96, 97, and 100 mm. were ripe. A male at 101 mm. was ripe. In others the diameter of the largest eggs were as follows:—

Length (mm.)	74	73	71	69	68	65	63	63	60	59
Diameter of largest Eggs (mm.) -	·19	·18	·21	·17	·2	·17	·16	·14	·16	·06

On 30th April most of the females were found to be spent, the ovaries being small and shrunken; in several cases a few fully-sized eggs which had failed to be expelled were present. The sizes of females which appeared to have spawned were as follows:—120, 118, 112, 111, 110, 109, 106, 105, 104, 102, 94, 93, 80 mm. The diameter of the eggs present in some cases is shown here:—

Length -	*120	*118	*111	109	106	104	68	58	56
Diameter of Eggs -	·19	·16	·16	·21	·18	·18	·14	·14	·14

*A few large old eggs also present.

In males of 109, 99, 96 mm. the testes were small and solid.

On 24th May no females contained ripe or large eggs. In one of 122 mm. the yolked eggs measured up to ·35 mm.; in another of 117 mm. they reached nearly the same size—viz., ·33 mm.; in one of 70 mm. they measured up to ·17 mm.

On 26th June females ranging about 111 mm. had yolked eggs measuring up to ·24 mm.; in one at 73 mm. they were ·2 mm.

On 26th May a female from the Dornoch Firth, 70 mm. in length, had eggs measuring ·09 mm. On 15th January a female of 144 mm. ($5\frac{3}{4}$ inches) taken in 57 fathoms at the Dog Hole, off Aberdeen, was full of almost ripe eggs, and on 17th December several from Aberdeen Bay from 92 mm. to 106 mm. appeared to be spent. A female of 92 mm. was taken off the Cromarty Firth in December with nearly ripe eggs.

From the above facts it appears that the spawning period of this species extends from the end of December to March or April. The occurrence of one with a few large fully mature eggs on 1st August was probably exceptional, and may have represented a late spawning, although the size of the fish is against that supposition. M'Intosh has described the eggs as having been found deposited on 1st October, and some of them were kept alive until they hatched on 2nd March.* With regard to the size when they first reach maturity, it appears probable that the females become mature when under 80 mm. in length, and the males when under 70 mm.

With respect to the rate of growth of the armed-bullhead the information in considerable. In the appended Table I have given the particulars of the measurements of certain lots, arranged in three-millimetre groups, from which it will be seen that three annual series are usually represented. The smallest examples were got in October, November, and December, and the next smallest in spring. The first question to be decided is whether these forms got in autumn and winter, varying from 47 and 49 mm. to 73 and 74 mm., are fish spawned at the preceding spawning season, *i.e.* under or about one year old. M'Intosh states that the larval and post-larval bullheads were not uncommon in St. Andrews Bay in April, measuring 7–8 mm., and that at the beginning of the month nearly ripe females were obtained. They were also got frequently in March, while in May they were abundant.† Specimens from 14 to 18 mm. were found from May to July; some in May were 19 mm.; and others at the end of June and beginning of July 25 and and 26 mm. Specimens were procured by the "Garland" in April up to 10 mm. Tosh gives the measurements of twenty-seven specimens of various sizes, and calculates that one in July, 17 mm. long, was about three months old; three, 25 and 26 mm. on 4th and 5th July, to be 5 to $5\frac{1}{2}$ months old; one on 24th February, measuring 46 mm., to be one year old, and others in May of 51 and 56 mm. to be fifteen months old; one in September, of 87 mm., to be one year and seven months old; one in December, 110 mm., to be one year and $10\frac{1}{2}$ months of age, and one of 138 mm. in the same month to be two years and eight months old.‡

In the push-net on the beach at Loch Fyne one of 27 mm. was taken on 3rd July, one of 34 mm. on 2nd July, and two of 41 and 52 mm. on 28th September.

On examining the Tables given below, it will be found that the first or youngest group in March is pretty well defined, and also the same group in August, and a calculation of the difference of the mean size indicates a growth in the period (of 139 days) of 27·2 mm. for the females and 26·3

* *Thirteenth Ann. Rep., Part III.*, p. 231.

† *Seventh Ann. Rep., Part III.*, p. 271.
Twelfth Ann. Rep., Part III., p. 334.

for the males; the averages in the two months being for females 62·9 and 90·1 mm., and for males 60·6 and 86·9. After August the growth does not appear to be rapid, the mean-size of the females of the group in October being on the 26th—for 100 specimens from 79 mm. to 108 mm.—95·3 mm., and on 31st (for eighty-six specimens from 80 to 111 mm.) 95·4 mm.; for the males the October averages are 89·2 mm. and 88·0 mm. In winter, as might be expected from the habitat in this case, growth is slow, as may be seen by comparing the corresponding groups in October–December and March, April.

In one or two instances two annual groups in the same series of measurements appear fairly complete, thus affording opportunity to deduce the amount of annual growth. Among the females on October 31st the first series has a mean-size of 63·3 mm. (or about $2\frac{1}{2}$ inches), the range extending from 57 to 70 mm.; the second series, as stated, is 95·4 mm., thus showing an annual increment of 32·1 mm. Among the males the first series also ranges from 57 to 70 mm., and has an average size of 62·4 mm.; the second series, from 73 to 98 mm., has a mean-size of 88·0 mm., showing an annual increment of 25·6 mm. In the December series, the average size of the males in the first group is 62·8 mm. and in the second group 87·6 mm., showing an annual increment of 24·8 mm. Among the females the first group has an average of 62·3 mm., and the second group an average of 94·2 mm.; the annual increment indicated being 31·9 mm.

Looking to these facts and the absence of the smaller forms in June, August, and the early part of September, the occurrence of one or two at the end of September, and the increase in their numbers later, I think there is little doubt that the first series represented in March is about one year old. And the phenomena presented by the ovarian eggs at different periods, and the measurements of the mature and immature fishes, as set forth above, make it probable that sexual maturity is not reached by the group until the second year. The largest specimen obtained, it may be added, the sex of which was not, however, ascertained, measured 156 mm. or $6\frac{1}{8}$ inches; it was from the Forth. The largest female determined was 136 mm. or $5\frac{3}{8}$ inches, and the largest male 141 mm. or $5\frac{6}{16}$ inches. They were both from the Solway. Contrary to what obtains among flat-fishes the males reach a size quite as large as the females, and presumably attain the same age.

Mm.	Solway—Females.													Forth—Mixed.		
	14 March.	30 April.	24 May.	26 June.	1 August.	14 August.	11 September.	27 September.	10 October.	26 October.	31 October.	27 November.	30 December.	10 May.	23 July.	19–21 August.
44	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
47	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...
50	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...
53	...	...	...	...	...	...	...	1	...	1	...	1	4	...	...	...
56	...	2	1	...	...	...	...	1	...	...	3	1	4	...	...	...
59	2	...	...	...	...	...	...	...	...	1	7	...	6	...	...	...
62	3	2	...	...	...	...	...	...	...	...	13	...	8	...	...	...
65	6	...	1	...	...	...	...	...	...	1	4	1	5	3	...	3
68	4	1	2	...	...	...	...	...	...	...	5	1	4	...	...	1
71	2	...	...	1	...	...	...	...	...	...	...	...	3	...	1	1
74	1	...	...	1	...	...	...	...	...	...	...	...	1	2	...	1
77	...	...	...	1	...	...	...	1	...	1	...	...	3	1	3	3
80	...	1	1	7	3	3	...	1	2	1	6	1	5	...	2	3
83	...	...	...	3	3	1	1	4	2	3	9	2	5	1	2	4
86	1	...	...	3	5	5	...	3	1	9	11	2	13	1	2	2
89	1	...	1	1	4	5	...	3	...	15	11	8	4	...	1	5
92	1	4	...	...	10	4	2	2	1	20	8	4	15	1	...	2
95	5	1	1	...	4	1	...	2	...	16	7	6	8	...	...	3
98	2	...	...	1	1	3	...	...	1	12	3	7	5	1	1	3
101	...	1	...	2	...	...	...	...	...	9	5	4	10	...	...	1
104	2	6	1	6	...	...	...	...	...	8	10	2	5	...	1	...
107	...	1	...	2	...	...	...	...	...	6	11	1	7	1	...	...
110	...	5	...	2	...	...	...	...	...	...	9	1	1	...	1	1
113	...	...	1	2	...	...	...	...	...	2	9	...	2	...	1	...
116	...	1	1	1	...	...	...	...	...	1	5	...	3	...	...	...
119	1	1	...	...	...	...	...	...	...	...	8	...	1	...	...	...
122	...	...	1	...	1	...	...	...	...	3	5	...	1	...	...	...
125	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...
128	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
131	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...
134	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
137	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
140	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
143	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
146	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
149	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
152	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
155	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...

Mm.	Solway—Males.													Aberdeen Bay—Mixed.		
	14 March.	30 April.	24 May.	26 June.	1 August.	14 August.	11 September.	27 September.	10 October	26 October.	31 October.	27 November.	30 December.	8 October.	31 October.	17 December.
44	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...
47	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	1
50	...	...	...	...	...	...	...	1	...	...	...	...	1	3	...	3
53	...	...	...	...	...	...	...	...	...	...	...	...	4	1		2
56	3	1	...	...	...	...	...	1	...	...	4	...	5	...	...	1
59	3	1	...	...	...	...	...	...	...	...	18	1	6	...	1	2
62	2	...	...	...	...	...	...	...	...	1	17	...	11	...	...	5
65	2	1	...	...	...	...	...	...	...	...	12	...	11	...	1	...
68	...	2	...	1	...	...	...	...	...	...	2	...	7	...	...	...
71	...	1	2	2	...	...	...	...	...	...	1	...	1	...	1	...
74	...	...	1	2	...	...	1	...	...	...	3	...	...	...	...	...
77	2	...	...	1	1	1	...	2	1	3	5	4	2	...	...	...
80	1	...	2	2	3	2	1	4	3	1	4	7	6	...	3	1
83	6	1	...	6	2	2	...	5	7	10	9	9	8	1	1	1
86	7	3	...	2	3	3	1	3	3	11	9	12	8	1	...	1
89	1	3	...	2	3	3	1	2	5	15	12	7	6	1	...	1
92	5	6	1	2	3	...	...	1	1	3	11	6	6	3	2	2
95	6	6	1	2	1	...	...	...	...	4	7	2	3	1	3	1
98	...	2	2	2	...	...	...	...	...	3	10	1	1	2	2	1
101	1	1	2	6	1	...	...	...	...	1	9	1	...	5	2	3
104	...	...	2	2	1	...	...	...	...	1	8	...	2	1	3	1
107	...	1	...	4	1	...	...	...	...	...	3	...	...	5	1	...
110	...	...	...	1	1	...	...	...	...	1	2	...	...	4	...	...
113	...	...	...	...	...	...	...	...	...	...	...	...	1	4	2	...
116	...	...	...	1	2	...	...	...	...	...	...	...	...	2	5	...
119	...	...	...	...	2	...	1	...	...	...	...	...	1	2	1	...
122	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...
125	...	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...
128	...	...	...	...	...	1	...	...	...	...	...	...	...	1	2	...
131	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...
134	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
137	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
140	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
143	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
146	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
149	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
152	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
155	...	...	...	...	—	...	...	...	...	...	...	...	...	...	...	...

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. Aberdeen Bay. Between Belhelvie and Black Dog.	1902. May 12.	44·2	45·0	45·0	11	12.30 p.m.	4.50 p.m.	Codling, ...	6	..	6	"Star of Peace." Wind N.N.E., force 5; sea choppy.
								Haddock, ...	6	..	6	
								Whiting, ...	..	5	5	
								Gurnard, ...	..	47	47	
								Plaice (2), ...	242	..	..	
								,, (3), ...	471	..	..	
									—713	13	726	
								Com. Dab, ...	653	363	1,016	
								Long Rough Dab,	..	8	8	
								Flounder, ...	4	1	1	
								Grey Skate, ..	..	5	5	
								Starry Ray, ..	..	11	11	
								Thornback, ..	..	2	2	
								Herring, ...	..	1	1	
								Angler, ...	..	68	68	
									1,282	524	1,906	
2. Same Locality.	,,	..	..	..	10 to 14½	5.15 p.m.	9.30 p.m.	Cod, ...	14	..	14	Wind N.N.E., blowing hard; sea choppy. Catch also included 123 edible crabs.
								Codling, ...	3	..	3	
								Coal-fish, ...	1	..	1	
								Whiting, ...	..	18	18	
								Haddock, ...	..	3	3	
								Plaice (1), ...	8	..	..	
								,, (2), ...	106	..	..	
								,, (3), ...	102	..	..	
									—216		216	
								Com. Dab, ...	427	283	710	
								Flounders, ..	13	9	22	
								Gurnard	..	19	19	
								Starry Ray, ..	..	41	41	
								Grey Skate, ..	..	5	5	
								Thornback, ..	..	5	5	
								Angler, ...	..	40	40	
								Herring, ...	..	1	1	
									674	424	1,098	
3. Aberdeen Bay From Cruden Scars to Stirling Quarries.	May 12 & 13.	..	..	..	11 to 18.	10.5 p.m.	2.15 p.m.	Cod, ...	26	..	..	Half a basket of unmarketable fish, chiefly Dabs.
								Codling, ...	9	..	..	
								Haddock, ...	5	..	..	
								Whiting, ...	7	..	..	
								Coal-fish, ...	5	..	..	
								Cat-fish, ...	1	..	..	
								Plaice (1), ...	½ basket	..	..	
								,, (2), ...	,,	..	..	
								,, (3), ...	,,	..	..	
								Brill, ...	2	..	..	
								Com. Dab, ...	1 basket	..	..	
4. Dog Hole, off Aberdeen.	May 13.	41·2	41·4	43·8	55	5.35 a.m.	6.40 a.m.	Cod, ...	1	..	1	Sea choppy.
								Codling, ...	15	..	15	
								Haddock, ...	24	..	24	
								Whiting, ...	20	..	20	
								Ling, ...	2	..	2	
								Coal-fish, ...	1	..	1	
								Plaice, ...	4	..	4	
								Lemon Dab, ..	42	..	42	
								Com. Dab, ...	2	..	2	
								Megrim, ...	11	..	11	
								Starry Ray, ..	..	7	7	
								Grey Skate, ..	..	1	1	
								Angler, ...	..	3	3	
									122	11	133	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
5. Aberdeen Bay, off Coastguard Station.	1902. May 13.	42·0	44·1	44·9	4 to 10	9.50 a.m.	11.20 a.m.	Cod, ...	1	..	..	Sea choppy; passing snow-showers.
								Haddock, ...	7	..	..	
								Plaice (1), ...	..	..	..	
								,, (2), ...	17	..	..	
								,, (3), ...	26	..	..	
									— 43	..	..	
								Com. Dab, ...	41	..	..	
								Grey Skate, ..	1	..	..	
									93	..	..	
6. Aberdeen Bay, off Collieston.	May 13.	..	..	..	12 to 14	12.5 p.m.	4.5 p.m.	Cod, ...	19	..	19	Fresh N. winds; sea choppy. 27 edible crabs taken.
								Codling, ...	7	..	7	
								Whiting, ...	..	1	1	
								Plaice (1), ...	16	..	..	
								,, (2), ...	50	..	..	
								,, (3), ...	36	..	..	
								,, (4).	42	..	..	
									—144	7	151	
								Lemon Dab, ..	1	..	1	
								Flounder, ...	1	2	3	
								Brill, ...	1	..	1	
								Com. Dab, ...	116	43	159	
								Grey Skate, ..	5	..	5	
								Starry Ray, ..	1	3	4	
								Thornback, ..	..	1	1	
								Herring, ...	..	4	4	
								Angler, ...	..	1	1	
									295	62	357	
7. Same Place.	May 13.	..	..	..	,,	4.45 p.m.	8.45 p.m.	Cod, ...	13	..	..	Wind light, N. by E. 37 edible crabs, one basket of unmarketable fishes, mostly Dabs, a few Flounders, Herring, Starry Ray, and Grey Skate.
								Haddock, ...	2	..	..	
								Plaice (1), ...	8	..	..	
								,, (2), ...	112	..	..	
								,, (3), ...	118	..	..	
								,, (4), ...	72	..	..	
									—310	..	..	
								Com. Dab, ...	207	..	..	
									532	..	..	
8. Between Slains Castle and Collieston.	May 13 & 14.	.. ..	..	..	11	9.40 p.m.	1.45 a.m.	Cod, ...	22	..	..	Catch included 42 edible crabs.
								Codling, ...	..	1	1	
								Haddock, ...	2	..	..	
								Plaice (1), ...	½ basket	..	..	
								,, (2), ...	1 ,,	..	..	
								,, (3), ...	½ ,,	1	..	
								Brill, ...	1	..	..	
								Halibut, ...	1	..	..	
								Com. Dab, ...	..	24	..	
								Skate, ...	24	1	..	
								Starry Ray, ..	..	10	..	
								Angler, ...	..	5	..	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
9. Moray Firth. Burghead Bay.	1902. May 15.	..	..	..	10 to 15	3.0 a.m.	7.0 .m.	Cod, ...	4	..	4	There were also taken 7 Norway lobsters, 5 crabs (marketable), and one squid.
								Codling, ...	4	..	4	
								Haddock (1), ..	51	..	..	
								,, (2), ..	46	..	..	
								,, (3), ..	252	..	..	
									—349	6	355	
								Whiting, ...	47	11	58	
								Gurnard, ...	76	27	103	
								Cat-fish, ...	5	..	5	
								Brill, ...	1	..	1	
								Plaice (1), ...	33	..	..	
								,, (2), ...	75	..	..	
								,, (3), ...	139	..	..	
								,, (4), ...	75	..	..	
									—322	11	333	
								Lemon Dab, ..	9	1	10	
								Com. Dab, ...	160	219	379	
								Witch, ...	59	..	59	
								Thornback, ..	7	1	8	
									1043	276	1319	
10. Same Place.	May 15.	..	..	..	12	7.45 a.m.	11.45 a.m.	Cod, ...	2	..	2	One edible crab was taken.
								Haddock (1), ..	66	..	..	
								,, (2), ..	20	..	..	
								,, (3), ..	178	..	..	
									—264	9	273	
								Whiting, ...	19	4	23	
								Gurnard, ...	30	44	74	
								Cat-fish, ...	10	..	10	
								Plaice (1), ...	9	..	..	
								,, (2), ...	33	..	..	
								,, (3), ...	103	..	..	
								,, (4), ...	274	..	..	
									—419	..	419	
								Lemon Dab, ..	4	..	4	
								Com. Dab, ...	537	290	827	
								Witch, ...	6	..	6	
								Grey Skate, ..	3	..	3	
								Thornback, ..	..	2	2	
								Angler, ...	..	37	37	
									1294	386	1680	
11. Off the Suters of Cromarty.	May 15.	..	..	..	8 to 12	12.20 p.m.	3.5 p.m.	Cod, ...	3	..	3	
								Codling, ...	72	7	79	
								Haddock (1), ..	124	..	..	
								,, (2), ..	41	..	..	
								,, (3), ..	160	..	..	
									—325	2	327	
								Whiting, ...	27	4	31	
								Gurnard, ...	16	7	23	
								Cat-fish, ...	2	..	2	
								Plaice (1), ...	3	..	..	
								,, (2), ...	17	..	..	
								,, (3), ...	39	..	..	
								,, (4), ...	20	..	..	
									— 79	..	79	
								Lemon Dab, ..	12	..	12	
								Com. Dab, ...	62	104	166	
								Witch, ...	33	..	33	
								Skate, ...	2	..	2	
								Herring, ...	..	4	4	
								Angler, ...	..	23	23	
									633	151	784	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
12. Off Burghead Bay.	1902. May 15.	..	..	..	6 to 30	7.40 p.m.	Midnight.	Cod, ...	3	..	3	Wind E. by E., strong.
								Codling, ...	..	9	9	
								Haddock (2) ..	6	..	..	
								,, (3), ..	36			
									—42	6	48	
								Whiting, ...	43	24	67	
								Coal fish, ..	1	..	1	
								Cat-fish, ...	3	..	3	
								Gurnard, ...	79	58	137	
								Halibut, ...	1	..	1	
								Brill, ...	1	..	1	
								Plaice (1), ...	37	..	..	
								,, (2), ...	243	..	..	
								,, (3), ...	38	..	..	
								,, (4), ...	31	..	..	
									—34	14	363	
								Lemon Dab, ..	4	2	6	
								Com. Dab, ...	216	246	462	
								Witch, ...	6	..	6	
								Grey Skate, ..	7	4	11	
								Angler, ...	..	27	27	
									755	390	1145	
13. Same Place.	May 16.	..	..	..	6 to 11	12.45 a.m.	5.15 a.m.	Cod, ...	10	..	10	Wind W., light; sea smooth.
								Codling, ...	10	6	16	
								Haddock (2), ..	10	..	..	
								,, (3), ..	69	..	..	
									—79	5	84	
								Whiting, ...	40	12	52	
								Gurnard, ...	76	62	138	
								Cat-fish, ...	5	..	5	
								Turbot, ...	1	..	1	
								Brill, ...	1	..	1	
								Plaice (1), ...	25	..	..	
								,, (2), ...	112	..	..	
								,, (3), ...	189	..	..	
								,, (4), ...	79	..	..	
									—405	24	429	
								Com. Dab, ..	151	110	261	
								Lemon Dab, ..	18	1	19	
								Witch, ...	16	..	16	
								Dragonet, ...	..	1	1	
								Angler, ...	..	51	51	
								Thornback, ..	..	8	8	
									812	280	1092	
14. Same Place.	May 16.	58·1	46·6	45·0	7 to 14	5.45 a.m.	9.45 a.m.	Cod, ...	5	..	5	Wind W., light; sea smooth.
								Haddock (1), ..	1	..	..	
								,, (3), ..	1	..	..	
									— 2	1	3	
								Whiting, ...	..	1	1	
								Cat-fish, ...	8	..	8	
								Gurnard, ...	54	26	80	
								Turbot, ...	1	..	1	
								Brill, ...	3	..	3	
								Plaice (1), ...	41	..	..	
								,, (2), ...	128	..	..	
								,, (3), ...	82	..	..	
								,, (4), ...	12	..	..	
									—263	7	270	
								Lemon Dab, ..	1	1	2	
								Com. Dab, ...	36	61	97	
								Thornback, ..	2	..	2	
								Angler, ...	..	15	15	
								Cuckoo Ray, ..	..	1	1	
									375	113	488	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
15. Same Place.	1902. May 16.	..	..	..	4½ to 18	10.25 a.m.	2.25 p.m.	Cod, ...	3	..	3	Wind N.E., light; sea smooth.
								Codling, ...	2	2	4	
								Haddock (1), ..	7	..	..	
								,, (3), ..	33	..	..	
									— 40	3	43	
								Whiting, ...	4	2	6	
								Gurnard, ...	121	27	148	
								Cat-fish, ...	1	..	1	
								Plaice (1), ...	32	..	..	
								,, (2), ...	194	..	..	
								,, (3), ...	76	..	..	
								,, (4), ...	13	..	..	
									—315	8	323	
								Brill, ...	2	..	2	
								Lemon Dab, ..	1	..	1	
								Com. Dab,.. ..	60	39	99	
								Thornback, ..	4	2	6	
								Angler, ...	..	21	21	
									553	104	657	
16. Same Place.	May 16.	..	..	..	6½ to 11	2.55 p.m.	7.5 p.m.	Cod, ...	1	..	1	Wind E. by N., force 5.
								Codling, ...	2	2	4	
								Haddock, ...	1	5	6	
								Whiting, ...	2	8	10	
								Cat-fish, ...	3	..	3	
								Gurnard, ...	142	26	168	
								Turbot, ...	2	..	2	
								Brill, ...	2	..	2	
								Plaice (1), ...	20	..	..	
								,, (2), ...	118	..	..	
								,, (3), ...	116	..	..	
								,, (4), ...	16	..	..	
									—270	12	282	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ..	62	29	91	
								Flounder, ...	1	..	1	
								Long Rough Dab,	..	1	1	
								Thornback, ..	8	2	10	
								Starry Ray, ..	..	1	1	
								Angler, ...	..	35	35	
									498	121	619	
17. Same Place	May 16.	..	..	..	12	7.25 p.m.	11.30 p.m.	Haddock (1), ..	3	..	..	Wind S.E. by S., force 5. Trawl was split.
								,, (3), ..	9	..	..	
									— 12	22	34	
								Whiting, ...	8	16	24	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	16	6	22	
								Turbot, ...	2	..	2	
								Brill, ...	1	..	1	
								Plaice (1), ...	2	..	.	
								,, (2), ...	7	..	..	
								,, (3), ...	19	..	..	
								,, (4), ...	1	..	..	
									— 29	5	34	
								Lemon Dab, ..	1	..	1	
								Com. Dab,.. ..	25	21	46	
								Thornback, ..	1	..	1	
								Angler, ...	..	12	12	
									96	82	178	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
17. Same Place.	1902. May 17.	..	..	..	6 to 12	2.30 p.m.	4.30 p.m	Cod, ...	3	..	3	Wind S.E. force 4. One edible crab caught.
								Codling, ...	8	23	31	
								Haddock (1), ..	3	..	..	
								,, (3), ..	58	..	..	
									— 61	1	62	
								Whiting, ...	9	17	26	
								Cat-fish, ...	2	..	2	
								Gurnard, ...	58	27	85	
								Brill, ...	4	..	4	
								Plaice (1), ...	19	..	..	
								,, (2), ...	172	..	..	
								,, (3), ...	62	..	..	
									—253	18	271	
								Lemon Dab, ..	8	..	8	
								Com. Dab, ...	140	134	274	
								Long Rough Dab,	..	2	2	
								Thornback, ..	2	2	4	
								Angler, ...	..	37	37	
									548	261	809	
18. Same Place.	May 17.	..	..	..	6 to 12	5 a.m.	9 a.m.	Cod, ...	6	..	6	
								Codling, ...	..	14	14	
								Haddock (1), ..	5	..	..	
								,, (3), ..	49	..	..	
									— 54	54	108	
								Whiting, ...	15	14	29	
								Gurnard, ...	41	47	88	
								Turbot, ...	3	..	3	
								Brill, ...	1	..	1	
								Plaice (1), ...	9	..	..	
								,, (2), ...	58	..	..	
								,, (3), ...	63	..	..	
								,, (4), ...	27	..	..	
									—157	9	166	
								Lemon Dab, ..	3	3	6	
								Com. Dab, ...	160	253	413	
								Witch, ...	1	..	1	
								Long Rough Dab,	..	6	6	
								Thornback, ..	3	..	3	
								Angler, ...	..	25	25	
									444	425	869	
19. Same Place.	May 17.	..	..	..	10 to 12	9.45 a.m.	1.50 p.m.	Cod, ...	2	..	2	Wind S.E. by E, force 3; sea slight. One edible crab.
								Codling, ...	..	1	1	
								Haddock, ...	11	10	21	
								Whiting, ...	..	2	2	
								Cat-fish, ...	5	..	5	
								Gurnard, ...	32	20	52	
								Turbot, ...	1	..	1	
								Brill, ...	1	..	1	
								Plaice (1), ...	8	..	..	
								,, (2), ...	61	..	..	
								,, (3), ...	86	..	..	
									—155	3	158	
								Lemon Dab, ..	4	1	5	
								Com. Dab, ..	50	56	106	
								Long Rough Dab,	..	5	5	
								Angler, ...	..	29	29	
									261	127	388	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
	1902.											
20 Same Place.	May 17.	..	..	..	5 to 22	2.25 p.m.	4.45 p.m.	Codling, ...	2	..	2	Wind E.S.E., force 5.
								Haddock, ...	2	3	5	
								Whiting, ...	6	1	7	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	23	8	31	
								Conger, ...	1	..	1	
								Turbot, ...	2	..	2	
								Plaice (1), ...	12	..	..	
								,, (2), ...	84	..	..	
								,, (3), ...	30	..	..	
								,, (4), ...	2	..	..	
									—128	..	128	
								Com. Dab, ...	36	7	43	
								Witch, ...	4	..	4	
								Long Rough Dab,	..	3	3	
								Thornback, ..	..	1	1	
									205	23	228	
21. Off Lybster.	May 19.	..	..	..	20 to 25	1.55 a.m.	6 a.m.	Cod, . ..	3	..	3	Wind N.N.E.
								Codling, ...	33	56	89	
								Haddock (1), ..	9	..	..	
								,, (2), ..	16	..	..	
								,, (3), ..	84	..	..	
									—109	32	141	
								Whiting, ...	102	104	206	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	27	490	517	
								Halibut, ...	1	..	1	
								Plaice (1), ...	4	..	..	
								,, (2), ...	16	..	..	
								,, (3), ...	45	..	..	
									— 65	..	65	
								Lemon Dab, ..	..	6	6	
								Com. Dab, ..	15	..	15	
									356	688	1044	
22. Smith Bank, 12 miles S.E. from Lybster.	May 19.	.	..	..	21 to 30	7.40 a.m.	11.50 a.m.	Cod, ...	2	..	2	Sea very choppy; wind strong from N. and N.N.E. Three squids.
								Codling, ...	5	1	6	
								Haddock (1), ..	46	..	..	
								,, (2), ..	87	..	..	
								,, (3), ..	261	..	..	
									—394	34	428	
								Whiting, ...	43	9	52	
								Cat-fish, ...	3	..	3	
								Gurnard, ...	185	619	804	
								Halibut, .. .	3	..	3	
								Turbot, ...	1	..	1	
								Brill, ...	1	..	1	
								Plaice (1), ...	..	..	..	
								,, (2), ...	84	..	..	
								,, (3), ...	22	..	..	
									—106	..	106	
								Lemon Dab (1), ..	46	..	..	
								,, (2), ..	34	..	..	
									— 80	2	82	
								Com. Dab, ...	19	187	206	
								Witch, ...	3	..	3	
								Long Rough Dab,	..	5	5	
								Thornback, ..	1	2	3	
								Cuckoo Ray, ..	1	..	1	
									847	859	1706	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
22. Burghead Bay.	1902. May 19.	..	..	..	8½ to 13	4 p.m.	8.15 p.m.	Cod, ...	3	..	3	Wind N. by E., force 7-8.
								Codling, ...	..	1	1	
								Haddock (1), ..	7	..	..	
								,, (3), ..	10	..	..	
									— 17	4	21	
								Whiting, ...	6	..	6	
								Cat-fish, ...	7	..	7	
								Gurnard, ...	246	72	318	
								Turbot, ...	2	..	2	
								Plaice (1), ...	11	..	..	
								,, (2), ...	109	..	..	
								,, (3), ...	171	..	..	
								,, (4), ...	53	..	..	
									—344	9	353	
								Lemon Dab, ..	2	1	3	
								Com. Dab, ...	262	136	398	
								Witch, ...	5	..	5	
								Long Rough Dab,	..	2	2	
								Thornback, ..	5	..	5	
								Angler, ...	61	61	61	
									899	286	1185	
23. Same Place.	May 19-20.	..	..	..	9 to 13	8.40 p.m.	2 a.m.	Cod, ...	1	..	1	Wind N., force 7; sea very choppy. Three edible crabs.
								Codling, ...	6	2	8	
								Haddock (1), ..	2	..	..	
								,, (2), ..	1	..	..	
								,, (3), ..	31	..	..	
									— 34	..	34	
								Whiting, ...	15	3	18	
								Cat-fish, ...	10	..	10	
								Gurnard, ...	145	58	203	
								Turbot, ...	1	..	1	
								Brill, ...	2	..	2	
								Plaice (1), ...	13	..	..	
								,, (2), ...	94	..	..	
								,, (3), ...	140	..	..	
								,, (4), ...	30	..	..	
									—277	7	284	
								Lemon Dab, ..	5	..	5	
								Com. Dab, ...	278	355	633	
								Witch, .. .	39	..	39	
								Long Rough Dao,	..	2	2	
								Thornback, ..	4	8	12	
								Angler, ...	..	32	32	
									817	467	1284	
24. Same Place.	May 20.	..	..	..	7 to 14	2.45 a.m.	6.45 a.m.	Cod, ...	6	..	6	Wind N. by W. One edible crab and several Norway lobsters.
								Codling, ...	7	3	10	
								Haddock (1), ..	6	..	..	
								,, (2), ..	6	..	..	
								,, (3), ..	37	..	..	
									— 49	2	51	
								Whiting, ...	17	2	19	
								Cat-fish, ...	6	..	6	
								Gurnard, ...	176	64	240	
								Brill, ...	5	..	5	
								Plaice (1), ...	15	..	..	
								,, (2), ...	58	.	..	
								,, (3), ...	173	..	..	
								,, (4), ...	83	..	..	
									—329	7	336	
								Lemon Dab, ..	14	..	14	
								Com. Dab, ..	348	347	695	
								Witch, ...	26	..	26	
								Long Rough Dab,	..	3	3	
								Thornback, ..	5	2	7	
								Angler, ...	..	48	48	
								Sapphirine Gurnard, ...	..	1	1	
									988	479	1467	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
25. Same Place.	1902. May 20.	..	..	..	8 to 13	7.10 a.m.	12.40 p.m.	Cod, ...	6	..	6	Wind N. by W., force 4.
								Haddock (1), ..	10	..	..	
								,, (2), ..	12	..	..	
								,, (3), ..	27	..	..	
									— 49	..	49	
								Whiting, ...	3	..	3	
								Cat-fish, ...	2	..	2	
								Conger, ...	1	..	1	
								Gurnard, ...	73	8	81	
								Turbot, ...	3	..	3	
								Brill, ...	1	..	1	
								Plaice (1), ...	34	..	..	
								,, (2), ...	261	..	..	
								,, (3), ...	124	..	..	
								,, (4).	51	..	..	
									—470	7	477	
								Lemon Dab (1), ..	3	..	..	
								,, (2), ..	2	..	..	
									— 5	..	5	
								Com. Dab, ..	143	155	298	
								Witch, ...	40	..	40	
								Thornback, ..	13	1	14	
								Angler, ...	..	46	46	
								Sapphirine Gurnard, ...	..	1	1	
									809	218	1027	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. 111 miles N.E. by E., easterly from Buchan Ness (In upper part Square XIX., about 80–85 miles S.S.E. of Sumburgh Head, Shetland.)	1902. May 23.	45·7	44·0	42·8	67½	4.40 a.m.	9.40 a.m.	Cod, ...	5	..	5	"Star of Peace." Slight S.W. wind; slight swell. Haddocks all spent; Whitings in roe.
								Codling, ...	130	..	130	
								Haddock (1), ..	436	..	..	
								,, (2), ..	174	..	..	
								,, (3), ..	835	2	..	
									—1445	..	1447	
								Whiting, ...	199	..	199	
								Ling, ...	1	1	2	
								Cat-fish, ...	2	..	2	
								Gurnard, ...	2	..	2	
								Megrim, ...	3	..	3	
								Witch (1), ...	144	..	..	
								,, (2), ...	167	11	..	
									— 311	..	322	
								Com. Dab, ..	..	3	3	
								Long Rough Dab,	..	517	517	
								Grey Skate, ..	2	..	2	
								Starry Ray, ..	..	14	14	
								Angler, ...	..	2	2	
									2100	550	2650	
2. Same Locality.	May 23	..	..	..	68½	10.10 a.m.	3.10 p.m.	Cod, ...	3	..	3	Moderate S.W. breeze; choppy sea. Soft bottom.
								Codling, ...	86	..	86	
								Haddock (1), ..	240	..	..	
								,, (2), ..	280	..	..	
								,, (3), ..	1183	..	..	
									—1703	..	1703	
								Whiting, ...	131	..	131	
								Coal-fish, ...	1	..	1	
								Hake, ...	1	..	1	
								Ling, ...	1	..	1	
								Tusk, ...	1	..	1	
								Cat-fish, ...	1	..	1	
								Megrim, ...	4	..	4	
								Witch (1), ...	70	..	..	
								,, (2), ...	127	..	..	
									— 197	23	220	
								Lemon Sole, ..	..	1	1	
								Long Rough Dab,	..	473	473	
								Starry Ray, ..	..	8	3	
								Angler, ...	..	..	1	
									2129	506	2635	
3. Same Locality.	May 23.	..	..	..	70	4.20 p.m.	9.20 p.m.	Cod, ...	7	..	7	Moderate S.W. to W. breeze; sea choppy.
								Codling, ...	63	..	63	
								Haddock (1), ..	253	..	..	
								,, (2), ..	243	..	..	
								,, (3), ..	858	..	..	
									—1354	1	1355	
								Whiting, ...	170	..	170	
								Coal-fish, . ..	4	..	4	
								Ling, ...	1	..	1	
								Tusk, ...	3	..	3	
								Cat-fish, ...	1	2	3	
								Gurnard, ...	2	2	4	
								Megrim, ...	8	..	8	
								Witch (1), ...	79	..	..	
								,, (2), ...	121	..	..	
									— 200	..	200	
								Lemon Sole, ..	2	..	2	
								Long Rough Dab,	..	523	523	
								Starry Ray, ..	..	20	20	
								Dog-fish, ...	..	1	1	
								Norway Haddock,	..	1	1	
								Angler, ...	..	4	4	
									1815	554	2369	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
4. Same Locality.	1902. May 23-24.	..	..	..	70	10.10 p.m.	3.10 a.m.	Cod, ...	4	..	..	Moderate breeze, S.W. to W.; sea choppy. Catch only partly enumerated.
								Codling, ...	1½ bskts.	1	..	
								Haddock (1), ..	3 ,,	..	..	
								,, (2), ..	1¼ ,,	..	..	
								,, (3), ..	3½ ,,	..	..	
								Whiting, ...	¼ ,,	..	..	
								Ling, ...	1	..	..	
								Hake, ...	1	..	..	
								Cat-fish, ...	1	..	..	
								Witch (1), ...	1 bskt.	..	..	
								,, (2), ...	¾ ,,	..	..	
								Long Rough Dab,	..	217	217	
								Norway Haddock,	..	1	1	
								Starry Ray, ..	..	20	20	
								Angler, ...	..	2	2	
5. About 45 miles N. ¼ E. from above. (Square XV., about 50 miles E. by S. of Sumburgh.)	May 24.	5·20	45·1	43·3	71	9.30 a.m.	2.30 p.m.	Cod, ...	4	..	4	Moderate breeze, W.S.W.; sea choppy. Numbers of Whitings in spawn. A Coal-fish contained in stomach 2 Argentines, 2 *Gadus esmarkii*, 1 Haddock.
								Codling, ...	106	..	106	
								Haddock (1), ..	264	..	..	
								,, (2), ..	79	..	..	
								,, (3), ..	253	..	..	
									—596	..	596	
								Whiting, ...	509	..	509	
								Coal-fish, ...	5	..	5	
								Hake, ...	6	..	6	
								Cat-fish, ...	12	..	12	
								Tusk, ...	2	..	2	
								Gurnard, ...	54	37	91	
								Halibut, ...	1	..	1	
								Megrim (1), ..	9	..	..	
								,, (2), ..	4	..	..	
									— 13	..	13	
								Witch (1), ...	43	..	..	
								,, (2), ...	19	..	..	
									— 62	..	62	
								Com. Dab, ...	3	32	35	
								Long Rough Dab,	..	154	154	
								Grey Skate, ..	2	..	2	
								Starry Ray, ..	..	8	8	
								Angler, ...	..	5	5	
									1375	236	1611	
6. Same Locality, steering N.E. by E. during trawl.	May 24.	..	..	..	76	3.20 p.m.	8.20 p.m.	Cod, ...	6	..	6	Fresh breeze, W.; heavy swell.
								Codling, ...	179	..	179	
								Haddock (1), ..	342	..	..	
								,, (2), ..	113	..	..	
								,, (3), ..	685	..	..	
									—1140	5	1145	
								Whiting, ...	1113	9	1122	
								Coal-fish, ...	2	..	2	
								Hake, ...	6	..	6	
								Ling, ...	4	..	4	
								Cat-fish, ...	8	..	8	
								Tusk, ...	1	..	1	
								Gurnard, ...	32	33	65	
								Halibut, ...	2	..	2	
								Megrim (1), ..	69	..	..	
								,, (2), ..	98	..	..	
									—167	..	167	
								Witch (1), ...	11	..	..	
								,, (2), ...	9	..	..	
									— 20	5	25	
								Com. Dab, ...	2	11	13	
								Long Rough Dab,	..	323	323	
								Norway Haddock,	..	1	1	
								Thornback, ..	2	..	2	
								Starry Ray, ..	..	29	29	
								Dog-fish, ...	..	1	1	
									2684	417	3101	

TRAWLING INVESTIGATIONS—TABLE I.

Place	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
7. About 10-12 miles N.E. by E. from above, and steering N.E.	1902. May 24-25.	..	..	..	71	9.5 p.m.	2.5 a.m.	Cod, ...	8	..	8	Moderate breeze, W.; heavy swell. Catch only partly enumerated.
								Codling, ...	..	1	1	
								Haddock, (1), ..	4½ bskts.	..	..	
								,, (2), ..	1 ,,	..	..	
								,, (3), ..	3 ,,	..	2	
								Whiting, ...	2 ,,	..	1	
								Coal-fish, ...	1	..	..	
								Ling, ...	2	..	..	
								Hake, ...	7	..	..	
								Cat-fish, ...	4	..	..	
								Gurnard, ...	16	7	23	
								Megrim, ...	5	..	..	
								Lemon Sole, ..	1	..	..	
								Com. Dab, ...	..	5	5	
								Long Rough Dab,	..	18	18	
								Starry Ray, ..	..	23	23	
8. About 10 miles N.E. of above, and steering N.-E. by E. for 2½ hours.	May 25.	..	..	..	78	3.20 a.m.	8.20 a.m.	Cod, ...	6	..	6	Moderate gale, shifting N.W. to S.W.; very choppy. A few Haddocks were found to be spawning.
								Codling, ...	45	..	45	
								Haddock (1), ..	240	..	..	
								,, (2), ..	79	..	..	
								,, (3), ..	287	..	..	
									—606	..	606	
								Whiting, ...	515	..	515	
								Hake, ...	11	..	11	
								Ling, ...	3	..	3	
								Tusk, ...	2	..	2	
								Cat-fish, ...	1	1	2	
								Gurnard, ...	22	4	26	
								Halibut, ...	1	..	1	
								Megrim (1), ..	12	..	..	
								,, (2), ..	9	..	..	
									— 21	3	24	
								Witch (1), ...	74	..	..	After this haul vessel steered S.W. for fifteen miles and hove to for heavy sea. Wind blowing a gale from S.W. On morning 26th wind hauled round to N.W. and moderated.
								,, (2), ...	43	..	..	
									—117	5	122	
								Com. Dab, ..	..	3	3	
								Long Rough Dab,	..	20	20	
								Grey Skate, ..	3	..	3	
								Angler, ...	..	5	5	
									1353	41	1394	
9. Near above (Lower edge Square XI.), Steering N.E. On taking lat. found it to be 60° 2′ N.	May 26.	46·5	45·0	43·5	60	7.45 a.m.	12.45 a.m.	Cod, ...	4	..	4	Wind N.W., fresh breeze; sea choppy; bottom shelly; net slightly split. A few Haddocks and many Whitings spawning.
								Codling, ...	72	..	72	
								Haddock (1), ..	260	..	..	
								,, (2), ..	103	..	..	
								,, (3), ..	148	..	..	
									—511	1	512	
								Whiting, ...	132	..	132	
								Coal-fish, ...	1	..	1	
								Cat-fish, ...	8		8	
								Gurnard, ...	30	14	44	
								Halibut, ...	1	..	1	
								Plaice, ...	2	..	2	
								Lemon Sole, ..	2	..	2	
								Megrim, ...	3	2	5	
								Witch (1), ...	12	..	..	
								,, (2), ...	4	..	..	
									— 16	..	16	
								Com. Dab, ...	..	78	78	
								Long Rough Dab,	..	32	32	
								Grey Skate, ..	..	1	1	
								Starry Ray, ..	..	7	7	
								Angler, ...	..	1	1	
									782	136	918	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
10. Same Locality.	1902. May 26	..	..	..	58	1.55 p.m.	6.55 p.m.	Cod, ...	4	..	4	Wind W.; moderate breeze; sea choppy.
								Codling, ...	154	11	165	
								Haddock (1), ..	292	..	..	
								,, (2), ..	123	..	..	
								,, (3), ..	222	..	..	
									—637	5	642	
								Whiting, ...	265	4	269	
								Hake, ...	1	..	1	
								Ling, ...	4	..	4	
								Tusk, ...	2	..	2	
								Coal-fish, ...	2	..	2	
								Cat-fish, ...	9	..	9	
								Gurnard, ...	27	23	50	
								Halibut, ...	1	..	1	
								Plaice, ...	3	..	3	
								Lemon Sole, ..	3	..	3	
								Megrim (1), ..	2	..	..	
								,, (2), ..	2	..	..	
									— 4	..	4	
								Witch (1), ...	22	..	..	
								,, (2), ...	10	..	..	
									— 32	1	33	
								Com. Dab, ...	..	83	83	
								Long Rough Dab,	..	46	46	
								Grey Skate, ..	1	..	1	
								Starry Ray, ..		18	18	
									1149	191	1340	
11. Same Locality.	May 26–27.	..	..	..	63	7.45 p.m.	12.45 a.m.	Cod, ...	2	..	2	Moderate S.W. breeze; sea choppy. Catch only partly enumerated.
								Codling, ...	1 bskt.	..	..	
								Haddock (1), ..	4 bskts.	..	.	
								,, (2), ..	¾ ,,	..	..	
								,, (3), ..	2 ,,	..	..	
								Whiting, ...	1 ,,	..	..	
								Ling, ...	1	..	1	
								Tusk, ...	1	..	1	
								Cat-fish, ...	4	..	4	
								Gurnard, ...	..	7	7	
								Halibut, ...	1	..	1	
								Plaice, ...	1	..	1	
								Lemon Sole, ..	1	..	1	
								Megrim, ...	1	..	1	
								Witch (1), ...	14	..	..	
								,, (2), ...	4	..	..	
									— 18	..	18	
								Com. Dab, ...	..	72	72	
								Long Rough Dab,	..	19	19	
								Grey Skate, ..	..	1	1	
								Starry Ray, ..	..	7	7	
12. Same	May 27.	..	..	..	58 to 66	2.50 a.m.	7.50 a.m.					Moderate W. S.W. breeze; swell on sea. The net was torn and lost. except ground rope. Soundings showed sandy and rocky bottom. Vessel then steamed S.W. 32 miles.

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Traw Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
13. About 32 miles S.W. of above (SquareXV.), ? on west of Bressay Shoal.	1902. May 27.	46·0	44·6	42·9	74	11.50 a.m.	4.50 p.m.	Cod, ...	7	..	7	Gentle breeze S.W. by W.; swell on sea. Bottom mud. One Haddock observed to be spawning.
								Codling, ...	92	2	94	
								Haddock (1), ..	258	..	..	
								,, (2), ..	76	..	..	
								,, (3), ..	286	..	..	
									—620	7	627	
								Whiting, ...	85	4	89	
								Coal-fish, ...	1	..	1	
								Tusk, ...	2	..	2	
								Cat-fish	1	..	1	
								Gurnard, ...	3	5	8	
								Halibut, ...	2	..	2	
								Megrim (2), ..	3	3	6	
								Witch (1), ...	52	..	..	
								,, (2), ...	87	..	..	
									—139	..	139	
								Lemon Sole, ..	2	..	2	
								Com. Dab, ..	..	5	5	
								Long Rough Dab,	..	672	672	
								Starry Ray, ..	..	10	10	
								Angler, ...	..	4	4	
								Norway Haddock,	..	1	1	
									957	713	1670	
14. Same.	May 27.	..	..	..	73	5.35 p.m.	10.35 p.m.	Cod, ...	..	..	..	Wind S.W. by W.; fresh breeze; sea choppy. Bottom mud. Catch only partly enumerated.
								Codling, ...	1½ bskts.	1	..	
								Haddock (1), ..	2¾ ,,	..	..	
								,, (2), ..	½ ,,	..	..	
								,, (3), ..	3 ,,	10	..	
								Whiting, ...	¾ ,,	..	..	
								Coal-fish	11	..	..	
								Cat-fish, ...	1	..	..	
								Lemon Sole, ..	..	1	..	
								Witches (1), ..	¾ bskt.	2	..	
								,, (2), ..	¼ ,,	..	..	
								Megrim, ...	..	2	..	
								Com. Dab, ...	..	1	..	
								Long Rough Dab,	..	327	..	
								Gurnard, ...	..	1	..	
								Grey Skate, ..	3	1	..	
								Angler, ...	..	2	..	
								Starry Ray, ..	..	29	..	
15. Same.	May 27–28	..	..	..	72	21.30 p.m.	4.30 a.m.	Cod, ...	3	..	3	Fresh breeze S.W.; sea choppy.
								Codling, ...	45	2	47	
								Haddock (1), ..	97	..	..	
								,, (2), ..	20	...	..	
								,, (3), ..	325	..	..	
									—442	13	455	
								Whiting, ...	27	..	27	
								Coal-fish, ...	2	..	2	
								Cat-fish, ...	2	..	2	
								Megrim, ...	9	3	12	
								Witch (1), ...	67	..	..	
								,, (2), ...	42	..	..	
									—109	5	114	
								Com. Dab, ..	..	2	2	
								Long Rough Dab,	..	234	234	
								Starry Ray, ..	..	43	43	
								Angler, ...	1	4	5	
									640	306	946	
16. Same Place. (Ran home S.W. 140 miles to Buchan Ness.)	May 28.	46·4	45·0	43·8	70	5.26 a.m.	6.1 a.m.	Cod, ...	1	..	1	Strong S.W. breeze; sea choppy. Bottom mud.
								Codling, ...	5	..	5	
								Haddock, ...	41	..	41	
								Whiting, ...	2	..	2	
								Witch, ...	6	..	6	
									55	..	55	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
1. "Fisher Bank." Course steered E. by S. for 170 miles from Girdleness. (Square XXV., about 105 miles from coast of Norway.	1902. May 31.	50·5	48·2	43·2	34	8 a.m.	Noon	Codling, ...	5	..	5	"Caledonia I." Moderate easterly breeze. Bottom sandy.
								Haddock (1), ..	43	..	..	
								,, (2), ..	47	..	..	
								,, (3), ..	140	..	..	
									—230	78	308	
								Whiting, ...	37	20	57	
								Cat-fish, ...	5	..	5	
								Gurnard, ...	7	3	10	
								Halibut, ...	1	..	1	
								Plaice, ...	40	..	40	
								Com. Dab, ...	..	1	1	
								Grey Skate, ..	1	..	1	
								Starry Ray, ..	..	4	4	
									326	106	432	
2. Same Place.	May 31.	..	..	13·8	,,	12.30 p.m.	4.30 p.m.	Cod, ...	5	..	5	Moderate easterly breeze; sea choppy.
								Codling, ...	4	7	11	
								Haddock (1), ..	103	..	..	
								,, (2), ..	34	..	..	
								,, (3). ..	76	..	..	
									—213	93	306	
								Whiting, ...	25	11	36	
								Ling, ...	1	..	1	
								Cat-fish, ...	5	..	5	
								Halibut, ...	1	..	1	
								Plaice, ...	73	..	73	
								Com. Dab, ...	..	2	2	
								Starry Ray, ..	..	5	5	
									327	118	445	
3. Same Place.	May 31.	..	..	..	33	5 p.m.	9 p.m.	Cod, ...	15	..	15	Fresh breeze, N.E.; sea choppy.
								Codling, ...	..	2	2	
								Haddock (1), ..	67	..	..	
								,, (2), ..	23	..	..	
								,, (3), ..	73	..	..	
									—163	97	260	
								Whiting, ...	58	11	69	
								Cat-fish, ...	5	..	5	
								Gurnard, ...	6	2	8	
								Plaice, ...	53	..	53	
								Lemon Sole, ..	2	..	2	
								Witch, ...	1	..	1	
								Com. Dab, ...	..	3	3	
								Long Rough Dab,	..	2	2	
								Starry Ray,	..	2	2	
									303	119	422	
4. Same Place.	May 31-June 1.	..	..	..	32	9.30 p.m.	1.30 a.m.	Cod, ...	7	..	..	Fresh N.E. breeze; sea choppy. One basket of offal, chiefly Haddocks.
								Haddock (1), ..	1 bskt.	..	..	
								,, (2), ..	½ ,,	..	..	
								,, (3). ..	½ ,,	..	..	
								Plaice, ...	2 ,,	..	..	
5. Same Place.	June 1.	..	..	..	33	2 a.m.	6 a.m.	Cod, ...	1	..	1	Weather and sea as before
								Codling, ...	..	10	10	
								Haddock (1), ..	93	..	..	
								,, (2), ..	37	..	..	
								,, (3), ..	107	..	..	
									—237	215	452	
								Whiting, ...	23	23	46	
								Gurnard, ...	8	3	11	
								Cat-fish, ...	3	..	3	
								Halibut, ...	3	..	3	
								Plaice, ...	84	..	84	
								Lemon Sole, ..	2	..	2	
								Witch, ...	1	..	1	
								Com. Dab, ...	2	5	7	
								Long Rough Dab,	..	7	7	
								Starry Ray, ..	..	11	11	
								Angler, ...	..	2	2	
									364	276	640	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
6. Same Place.	1902. June 1.	52·3	48·9	43·8	34	6.30 a.m.	10.30 a.m.	Cod, ...	6	..	6	Weather as before.
								Codling, ...	2	2	4	
								Haddock (1), ..	59	..	..	
								,, (2), ..	11	..	..	
								,, (3), ..	24	..	..	
									— 94	35	129	
								Whiting, ...	18	4	22	
								Coal-fish, ...	2	..	2	
								Ling, ...	1	..	1	
								Cat-fish, ...	6	..	6	
								Gurnard, ...	3	2	5	
								Plaice, ...	83	..	83	
								Lemon Sole, ..	2	..	2	
								Witch, ...	1	..	1	
								Com. Dab, ...	..	2	2	
								Long Rough Dab,	..	8	8	
								Angler, ...	..	2	2	
									218	55	273	
7. Same Locality.	June 1.	..	..	..	32½	11 a.m.	3 p.m.	Codling, ...	6	2	8	Moderate N.N.E. breeze; sea choppy.
								Haddock (1), ..	78	..	..	
								,, (2), ..	21	..	..	
								,, (3), ..	3	..	..	
									—102	16	118	
								Whiting, ...	..	3	3	
								Cat-fish, ...	2	..	2	
								Gurnard, ...	2	..	2	
								Plaice, ...	91	..	91	
								Lemon Sole, ..	1	..	1	
								Com. Dab, ...	..	5	5	
								Long Rough Dab,	..	4	4	
								Angler, ...	..	1	1	
									204	31	235	
8. Same Locality.	June 1.	..	..	..	33	3.30 p.m.	7.30 p.m.	Cod, ...	19	..	19	Gentle N. N. E. breeze; heavy swell on sea.
								Codling, ...	9	11	20	
								Haddock (1), ..	127	..	..	
								,, (2), ..	58	..	..	
								,, (3), ..	29	..	..	
									—214	197	411	
								Whiting, ...	80	9	89	
								Coal-fish, ...	3	..	3	
								Gurnard, ...	3	..	3	
								Plaice, ...	72	..	72	
								Lemon Sole, ..	1	1	2	
								Com. Dab, ...	..	6	6	
								Long Rough Dab,	..	2	2	
									401	226	627	
9. Same Locality.	June 1.	.	..	..	33	8 p.m.	12 p.m.	Haddock (1), ..	1 bskt.	..	..	Gentle N.E. breeze; heavy swell. Offal consisted of about ¼ basket, chiefly Haddocks.
								,, (2), ..	¼ ,,	..	..	
								,, (3), ..	¼ ,,	..	..	
								Coal-fish, ...	1	..	..	
								Cat-fish, ...	2	..	..	
								Plaice, ...	1 bskt.	..	.	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard	Total No.	
10. Same Place.	1902. June 2.	..	..	..	33	12.30 a.m.	4.30 a.m.	Cod, ...	6	..	..	Fresh easterly breeze; sea choppy. ¼ basket offal, chiefly Haddocks.
								Haddock (1), ..	2 bskts.	..	..	
								,, (2), ..	¼ ,,	..	..	
								,, (3), ..	¼ ,,	..	..	
								Coal-fish, ...	2	..	..	
								Cat-fish, ...	3	..	..	
								Plaice, ...	1 bskt.	..	..	
11. Same Place.	June 2.	49·6	48·4	43·2	34	5 a.m.	9 a.m.	Cod, ...	3	..	3	Strong easterly breeze; sea choppy.
								Codling, ...	5	7	12	
								Haddock (1), ..	98	..	..	
								,, (2), ..	73	..	..	
								,, (3), ..	140	..	..	
									—311	243	554	
								Whiting, ...	34	17	51	
								Gurnard, ...	..	4	4	
								Halibut, ...	1	..	1	
								Plaice, ...	15	..	15	
								Lemon Sole, ..	2	..	2	
									371	271	642	
12. Same Locality.	June 2.	..	..	..	37	9.30 a.m.	1.30 p.m.	Cod, ...	3	..	3	Strong easterly breeze; sea choppy. No Haddocks observed in spawn in this locality. After this drag the vessel steamed about 45 miles in a N. W. by W. direction.
								Codling, ...	3	4	7	
								Haddock (1), ..	157	..	..	
								,, (2), ..	63	..	..	
								,, (3), ..	52	..	..	
									—272	27	299	
								Whiting, ...	48	2	50	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	4	3	7	
								Plaice, ...	8	..	8	
								Lemon Sole, ..	1	..	1	
								Witch, ...	1	..	1	
								Long Rough Dab,	..	3	3	
									341	39	380	
13. About 90 miles E. of Buchan Ness (Square XXIV.).	June 2.	..	..	..	60	6 p.m.	10 p.m.	Cod, ...	12	..	..	Moderate S.S.E. breeze. Fine sandy bottom. Catch not completely recorded.
								Haddock, ...	1 bskt.	..	..	
								Witches, ...	1½ ,,	..	..	
								Argentines, ..	..	2	..	
14. Same Locality.	June 2-3.	..	..	..	80	10.30 p.m.	2.30 a.m.	Cod, ...	15	..	15	Light N.W. breeze: swell on sea.
								Codling, ...	52	..	52	
								Haddock (1), ..	98	..	..	
								,, (2), ..	34	..	..	
								,, (3), ..	29	..	..	
									—161	3	164	
								Whiting, ...	33	2	35	
								Coal-fish, ...	5	..	5	
								Ling, ...	1	..	1	
								Tusk, ...	1	..	1	
								Megrim, ...	4	..	4	
								Witch (1), ...	49	..	..	
								,, (2), ...	106	..	..	
									—155	1	156	
								Long Rough Dab,	..	31	31	
								Angler, ...	2	..	2	
									429	37	466	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
15. Same Locality.	1902. June 3.	..	..	..	81	3 a.m.	7 a.m.	Cod, ...	5	..	5	Light N.W. breeze; swell on sea.
								Codling, ...	136	6	142	
								Haddock (1), ..	132	..	..	
								,, (2), ..	39	..	..	
								,, (3), ..	50	..	..	
									—221	8	229	
								Whiting, ...	..	17	17	
								Coal-fish, ...	6	..	6	
								Ling, ...	2	..	2	
								Tusk, ...	1	..	1	
								Witch (1), ...	103	..	..	
								,, (2), ...	147	..	..	
									—250	3	253	
								Long Rough Dab,	..	23	23	
								Grey Skate, ..	1	..	1	
								Angler, ...	6	..	6	
								Norway Haddock,	..	5	5	
									628	62	690	
16. Same Locality.	June 3.	50·9	46·0	42·9	79	7.30 a.m.	11.30 a.m.	Cod, ...	11	..	11	Gentle breeze from S.S.E.; swell on sea. One Haddock observed to be spawning.
								Codling, ...	122	..	122	
								Haddock (1). ..	131	..	..	
								,, (2). ..	41	..	..	
								,, (3), ..	103	..	..	
									—275	17	292	
								Whiting, ...	223	84	307	
								Coal-fish, ...	3	..	3	
								Ling, .. .	4	..	4	
								Tusk, ...	3	..	3	
								Gurnard, ...	..	3	3	
								Megrim, ...	7	..	7	
								Witch (1), ...	97	..	..	
								,, (2), ...	54	..	..	
									—151	4	155	
								Com. Dab, ...	..	2	2	
								Long Rough Dab,	..	57	57	
								Angler, ...	6	..	6	
								Bib, ...	..	1	1	
									805	168	973	
17. Same Locality.	June 3.	..	..	..	81	noon	4.0 p.m.	Cod, ...	12	..	12	Moderate breeze S.S.E.; sea choppy; thunderstorm. Bottom mud.
								Codling, ...	93	7	100	
								Haddock (1), ..	122	..	..	
								,, (2), ..	53	..	..	
								,, (3), ..	97	..	..	
									—272	9	281	
								Whiting, ...	40	6	46	
								Coal-fish, ...	2	..	2	
								Ling, ...	1	..	1	
								Tusk, ...	3	..	3	
								Gurnard, ...	3	2	5	
								Megrim, ...	15	3	18	
								Witch (1), ...	137	..	..	
								,, (2), ...	183	..	..	
									—320	15	335	
								Long Rough Dab,	..	23	23	
								Grey Skate, ..	1	..	1	
								Angler, ...	..	1	1	
								Norway Haddock,	..	3	3	
									762	69	831	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market	No. thrown Overboard.	Total No.	
18. Same Locality.	1902. June 3.	..	..	..	80	4.30 p.m.	8.30 p.m.	Codling, ...	91	..	91	Moderate S.E. breeze; sea choppy. Bottom mud.
								Haddock (1), ..	118	..	..	
								,, (2), ..	43	..	..	
								,, (3), ..	159	..	..	
									—320	7	327	
								Whiting, ...	32	2	34	
								Coal-fish, ...	8	..	8	
								Ling, ...	2	1	3	
								Tusk, ...	2	..	2	
								Gurnard, ...	5	4	9	
								Megrim, ...	91	..	91	
								Witch (1), ...	83	..	..	
								,, (2), ...	173	..	..	
									—256	7	263	
								Long Rough Dab,	..	47	47	
								Angler, ...	7	..	7	
								Bib, ...	..	1	1	
								Argentine, ..	..	3	3	
									814	72	886	
19. Same Locality.	June 3 and 4.	..	..	..	76	9.0 p.m.	1.0 a.m.	Cod, ...	10	..	..	Gentle E.S.E. breeze; swell on sea. Bottom mud. Catch incompletely recorded.
								Coal-fish, ...	3	..	..	
								Haddock (1), ..	2 bskts.	..	..	
								,, (2), ..	½ ,,	..	..	
								,, (3), ..	½ ,,	..	..	
20. Same Locality	June 4.	..	..	..	77	1.30 a.m.	5.30 a.m.	Cod, ...	15	..	..	Weather as before. Catch incompletely recorded.
								Ling, ...	1	..	..	
								Coal-fish, ...	2	..	..	
								Haddock (1), ..	3 bskts.	..	..	
								,, (2), ..	½ ,,	..	..	
								,, (3), ..	¼ ,,	..	..	
21. Same Locality.	June 4.	51·0	46·0	42·8	76	6.0 a.m.	10.0 a.m.	Cod, ...	7	..	7	Light breeze from S.S.E; slight swell. Bottom mud.
								Codling, ...	62	1	63	
								Haddock (1), ..	107	..	..	
								,, (2). ..	41	..	..	
								,, (3), ..	131	..	..	
									—279	3	282	
								Whiting, ...	42	4	46	
								Coal-fish, ...	9	..	9	
								Ling, ...	5	..	5	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	9	5	14	
								Megrim, ...	15	..	15	
								Witch (1), ...	81	..	..	
								,, (2), ...	127	..	..	
									—208	6	214	
								Long Rough Dab,	..	65	65	
								Bib, ...	..	2	2	
								Norway Pout, ..	..	2	2	
								,, Haddock,	..	2	2	
								Lumpenus, ..	..	1	1	
								Angler, ...	5	..	5	
									642	91	733	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
22. Same Locality.	1902. June 4.	..	..	..	76	10.30 a.m.	2.30 p.m.	Cod, ...	19	..	19	Light airs, S.E.; slight swell. Bottom mud.
								Codling, ...	..	1	1	
								Haddock (1), ..	73	..	..	
								,, (2), ..	30	..	..	
								,, (3), ..	94	..	..	
									—217	2	219	
								Whiting, ...	27	1	28	
								Coal-fish, ...	4	..	4	
								Ling, ...	2	..	2	
								Gurnard, ...	3	2	5	
								Halibut, ...	1	..	1	
								Megrim, ...	11	..	11	
								Witch (1), ...	75	..	..	
								,, (2), ...	123	..	..	
									—198	..	198	
								Lemon Sole, ..	1	..	1	
								Long Rough Dab,	..	167	167	
								Starry Ray, ..	..	1	1	
								Angler, ...	8	..	8	
									491	174	665	
23. Same Locality.	June 4.	49·3	46·3	43·2	71	3.0 p.m.	7.0 p.m.	Cod, ...	12	..	12	Light S.E. breeze; sea smooth. Bottom mud.
								Codling, ...	26	1	27	
								Haddock (1), ..	71	..	..	
								,, (2), ..	60	..	..	
								,, (3), ..	178	..	..	
									—309	27	336	
								Whiting, ...	24	3	27	
								Coal-fish, ...	1	..	1	
								Gurnard, ...	3	1	4	
								Megrim, ...	9	..	9	
								Witch (1), ...	101	..	..	
								,, (2), ...	77	..	..	
									—178	3	181	
								Long Rough Dab,	..	43	43	
								Angler, ...	3	..	3	
								Norway Pout, ..	..	2	2	
								Herring, ...	..	1	1	
									565	81	646	
24. Same Locality.	June 4.	..	..	..	64	7.30 p.m.	11.30 p.m.	Cod, ...	5	..	..	Light airs; sea smooth. Bottom mud. Catch only partly recorded.
								Haddock (1), ..	1 bask't	..	..	
								,, (2), ..	½ ,,	..	..	
								,, (3). ..	¼ ,,	..	..	
								Whiting, ...	¼ ,,	..	..	
								Cat-fish, ...	1	..	..	
								Witches (1), ..	20	..	..	
								,, (2), ..	30	..	..	
									— 50	..	..	
								Angler	3	..	..	
									22	..	22	
25. Same Locality.	June 5.	..	..	..	64	12.0 a.m.	4.0 a.m.	Cod, ...	25	1	26	Calm: sea smooth.
								Codling, ...	27	..	..	
								Haddock (1), ..	25	..	..	
								,, (2), ..	297	..	..	
								,, (3), ..	—349	5	354	
									..	3	3	
								Whiting, ...	13	..	13	
								Coal-fish, ...	1	..	1	
								Hake, ...	2	..	2	
								Ling, ...	4	2	6	
								Gurnard, ...	2	..	2	
								Cat-fish, ...	1	..	1	
								Turbot, ...	9	..	9	
								Megrim, ...	61	..	..	
								Witch (1), ...	72	..	..	
								,, (2), ...	—133	2	135	
									..	17	17	
								Long Rough Dab,	1	..	1	
								Mackerel, ...	..	3	3	
								Argentine, ..	562	33	595	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
26. Same Locality.	1902. June 5.	50·2	47·0	43·2	66	5.45 a.m.	9·45 a.m.	Cod, ...	7	..	7	Dense fog; calm; sea smooth. Bottom mud.
								Codling, ...	28	2	30	
								Haddock (1), ..	69	..	..	
								,, (2), ..	93	..	..	
								,, (3), ..	173	..	..	
									—335	80	415	
								Whiting, ...	16	2	18	
								Coal-fish, ...	30	..	30	
								Hake, ...	1	..	1	
								Gurnard, ...	1	2	3	
								Megrim, ...	7	..	7	
								Witch (1), ...	47	..	..	
								,, (2), ...	43	..	..	
									— 90	3	93	
								Long Rough Dab,	..	79	79	
								Grey Skate, ..	1	..	1	
								Starry Ray, ..	..	1	1	
								Angler, ...	3	..	3	
								Bib, ...	..	1	1	
									519	170	689	
27. Same Locality.	June 5.	..	..	..	70	10.15 a.m.	2.15 p.m.	Cod, ...	9	..	9	Calm; smooth; dense fog. Bottom mud. After this drag steered W.S.W. for Aberdeen, and ran 74 miles.
								Haddock (1), ..	44	..	..	
								,, (2), ..	47	..	..	
								,, (3), ..	328	..	..	
									—419	43	462	
								Whiting, ...	73	3	76	
								Coal-fish, ...	21	..	21	
								Ling, ...	2	..	2	
								Gurnard, ...	3	6	9	
								Megrim, ...	14	1	15	
								Witch (1), ...	29	..	..	
								,, (2), ...	19	..	..	
									— 48	5	53	
								Long Rough Dab,	..	54	54	
								Grey Skate, ..	1	..	1	
								Starry Ray, ..	..	1	1	
								Angler, ...	1	..	1	
								Argentine, ..	..	1	1	
									591	114	705	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. Aberdeen Bay, off Black Dog.	1902. Oct. 2.	..	..	..	20 to 4	6.0 p.m.	11.20 p.m.	Cod, ...	1	..	1	"Star of the Sea," Beam trawl 50 ft. 6 in. long. Shot in 20 fms. and towed nto 4 fms. and out into 18 fms. There were 3 baskets of small Haddocks. ¼ basket of medium Plaice, ¼ basket of small Plaice, and 1 basket of Dabs.
								Codling, ...	12	..	12	
								Whiting, ...	60	15	75	
								Haddock, ...	668	101	769	
								Turbot	1	..	1	
								Plaice, ...	52	47	99	
								Com. Dab,.. ..	93	379	472	
								Long Rough Dab,	..	33	33	
								Gurnard, ...	..	32	32	
								Thornback, ..	..	9	9	
								Starry Ray, ..	..	7	7	
									887	623	1510	
2. Same Place.	Oct. 3.	..	..	..	6 to 17	12.15 a.m.	5.30 a.m.	Cod, ...	8	..	8	Otter trawl. Codlings were not enumerated. The catch in baskets was :—10 of small, ½ seconds, and ¼ large Haddocks ; 1 of large, 3 of medium, and ½ of small Plaice ; ¼ of Codlings, 1¼ Whitings, and 1 of Dabs.
								Codling, ...	¼ bskt.	..	..	
								Haddock (1), ..	32	..	..	
								,, (2), ..	59	..	..	
								,, (3), ..	2225	..	..	
									——2316	37	2353	
								Whiting, ...	161	9	170	
								Gurnard, ...	..	3	3	
								Plaice (1), ...	17	..	..	
								,, (2), ...	143	..	..	
								,, (3), ...	52	..	..	
								,, (4), ...	98	..	..	
									——310	62	372	
								Lemon Sole, ..	5	2	7	
								Com. Dab,.. ..	168	162	330	
								Long Rough Dab,	..	31	31	
								Thornback Ray, ..	..	6	6	
								Starry Ray, ..	..	13	13	
								Angler, ...	..	7	7	
									2968	332	3300	
3. Aberdeen Bay, off Collieston.	Oct. 3.	..	..	..	10to18	0 a.m.	9.30 a.m.	Cod, ...	5	..	5	The marketable counted, besides the Cod, Turbot, and Soles, of 23 baskets small, ¼ large, and ¼ medium Haddocks ; 4 baskets Whiting, 3¾ of Codlings, ½ of Dabs, and 3 of Plaice ;— or 34½ baskets.
								Codling, ...	578	45	623	
								Haddock (1), ..	32	..	..	
								,, (2), ..	52	..	..	
								,, (3), ..	4996	..	..	
									——5080	18	5098	
								Whiting, ...	690	82	772	
								Turbot, ...	3	..	3	
								Black Sole, ..	2	..	2	
								Plaice, ...	132	11	143	
								Lemon Sole, ..	2	2	4	
								Com. Dab,.. ..	240	124	364	
								Thornback, ..	..	2	2	
								Starry Ray, ..	..	7	7	
									6732	291	7023	
4. Moray Firth, Burghead Bay.	Oct. 4.	..	..	..	9 to 14	3.30 p.m.	7.40 p.m.	Cod, ...	2	..	..	Only the marketable were enumerated. The unmarketable consisted of 14 baskets, chiefly Gurnards and Dabs.
								Codling, ...	92	..	..	
								Haddock (1), ..	72	..	..	
								,, (3), ..	1011	..	.	
									——1083	..	..	
								Whiting, ...	150	..	..	
								Hake, ...	1	..	..	
								Ling, ...	1	..	..	
								Gurnard, ...	228	..	..	
								Plaice (1), ...	..	..	..	
								,, (2), ...	50	..	..	
								,, (3), ...	222	..	..	
								,, (4), ...	458	..	..	
									—730	..	..	
								Com. Dab,.. ..	27	..	..	
								Witch, ...	122	..	..	
								Lemon Sole, ..	21	..	..	
								Mackerel, ...	1	..	..	
								Angler, ...	..	8	..	
								Thornback, ..	15	..	..	
									2473	8	..	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
5. Same Place.	1902. Oct. 4-5.	..	..	..	5 to 20	8.20 p.m.	1.0 a.m.	Cod, ...	1	..	..	Mostly worked in 7–9½ fms. "Offal" thrown overboard, chiefly Dabs, consisted of 12 baskets.
								Codling, ...	41	..	..	
								Haddock (1), ..	..	..	..	
								,, (2), ..	60	..	..	
								,, (3), ..	1308	..	..	
								,, (4), ..	857	..	..	
									—2225	..	..	
								Whiting, ...	..	..	..	
								Gurnard, ...	200	..	..	
								Brill, ...	3	..	..	
								Plaice (1), ...	65	..	..	
								,, (2), ...	110	..	..	
								,, (3), ...	407	..	..	
								,, (4), ...	114	..	..	
									—696	..	..	
								Lemon Sole, ..	13	..	..	
								Black Sole, ..	1	..	..	
								Witch, ...	4	..	..	
								Com. Dab, ...	409	..	..	
								Thornback ..	3	..	..	
								Angler, ...	..	6	..	
									3596	..	..	
6. Same Place.	Oct. 5.	..	..	..	5 to 9	2.0 a.m.	6.20 a.m.	Codling, ...	40	..	..	Unmarketable fishes consisted of 15 basketfuls, chiefly Dabs.
								Haddock (1), ..	25	..	..	
								,, (2), ..	..	..	..	
								,, (3), ..	1989	..	..	
									—2014	..	..	
								Coal-fish, ...	2	..	..	
								Gurnard, ...	70	..	..	
								Plaice (1), ...	36	..	..	
								,, (2), ...	213	..	..	
								,, (3), ...	536	..	..	
								,, (4), ...	1354	..	..	
									—2139	..	..	
								Brill, ...	3	..	..	
								Lemon Sole, ..	36	..	..	
								Com. Dab, ...	482	..	..	
								Tnornback, ..	6	..	..	
								Angler, ...	..	7	..	
									4786	..	..	
7. Same Place.	Oct. 5.	..	..	..	4 to 8	8.0 a.m.	1.0 p.m.	Codling, ...	..	25	25	The catch included 240 Squids.
								Haddock (3), ..	278	12	290	
								Whiting, ...	3	4	7	
								Ling, ...	1	..	1	
								Gurnard, ...	153	21	174	
								Plaice (1), ...	174	..	..	
								,, (2, ...	824	..	..	
								,, (3), ...	548	..	..	
								,, (4), ...	160	..	..	
									—1706	425	2131	
								Com. Dab, ...	245	1640	1885	
								Lemon Sole, ..	..	3	3	
								Thornback, ..	11	3	14	
								Sand-eel, ...	..	2	2	
									2397	2135	4532	
8. Same Place.	Oct. 5.	..	..	..	5 to 13	1.45 p.m.	5.45 p.m.	Cod, ...	1	..	..	"Offal" consisted of six baskets.
								Codling, ...	29	..	..	
								Haddock (3), ..	1314	..	..	
								Gurnard, ...	40	..	..	
								Plaice (1), ...	56	..	..	
								,, (2), ...	358	..	..	
								,, (3), ...	432	..	..	
								,, (4), ...	2	..	..	
									—848	..	..	
								Brill, ...	2	..	..	
								Lemon Sole, ..	3	..	..	
								Com. Dab, ...	156	..	..	
								Thornback, ..	11	..	..	
									2404	..	..	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
9. Same Place.	1902. Oct 5.	..	..	..	6 to 13	6.30 p.m.	11.0 p.m.	Cod, ...	1	..	..	"Offal" consisted of six baskets.
								Codling, ...	40	..	..	
								Haddock (1), ..	25	..	..	
								,, (2), ..	..	..	..	
								,, (3), ..	1465	..	..	
									—1490	..	..	
								Whiting, ...	7	..	..	
								Gurnard, ...	40	..	..	
								Plaice, (1), ...	36	..	..	
								,, (2), ...	200	..	..	
								,, (3), ...	95	..	..	
								,, (4), ...	52	..	..	
									—383	..	..	
								Lemon Sole, ..	3	..	..	
								Brill, ...	7	..	..	
								Com. Dab, ...	62	..	..	
								Grey Skate, ..	1	..	..	
									2034	..	..	
10. Same Place.	Oct. 6.	..	..	..	,,	12.0 a.m.	1.0 a.m.	Codling, ...	12	..	..	
								Haddock (3), ..	320	..	..	
								Plaice (1), ...	5	..	..	
								,, (2), ...	74	..	..	
								,, (3), ...	100	..	..	
								,, (4), ...	75	..	..	
									—254	..	..	
								Com. Dab, ..	67	..	..	
								Thornback, ..	1	..	..	
									654	..	..	
12. Same Place.	Oct 6.	50·7	..	52·0	8 to 20	8.5 a.m.	12.20 p.m.	Codling, ...	27	..	27	Catch Included 400 ink-fish.
								Haddock (1), ..	24	..	..	
								,, (2), ..	..	..	..	
								,, (3), ..	17	..	..	
									— 41	9	50	
								Whiting, ...	..	..	1	
								Hake, ...	1	1	1	
								Gurnard, ...	108	30	138	
								Plaice (1), ...	40	..	..	
								,, (2), ...	145	..	..	
								,, (3), ...	295	..	..	
								,, (4), ...	130	..	..	
									—610	..	610	
								Brill, ...	1	..	1	
								Com. Dab, ...	70	730	800	
								Lemon Sole, ..	..	3	3	
								Witch, ...	75	..	75	
								Long Rough Dab,	..	30	30	
								Thornback, ..	4	..	4	
								Angler, ...	..	6	6	
									937	809	1746	
13. Same Place.	Oct. 6.	..	..	..	6 to 15	1.0 p.m.	5.30 p.m.	Codling, ...	6	..	..	A very large number of Dog fishes in net.
								Haddock (1), ..	22	..	..	
								,, (2), ..	..	..	..	
								,, (3), ..	440	..	..	
									—462	..	..	
								Gurnard, ...	45	..	..	
								Plaice (1), ...	46	..	..	
								,, (2), ...	115	..	..	
								,, (3), ...	212	..	..	
								,, (4), ...	164	..	..	
									—537	..	..	
								Brill, ...	11	..	..	
								Lemon Sole, ..	2	..	..	
								Com. Dab, ..	40	..	..	
								Witch, ...	25	..	..	
								Thornback, ..	3	..	..	
									1131	..	..	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
14. Dornoch Firth, off Dunrobin	1902. Oct. 6-7	..	..	..	8 to 13	9.0 p.m.	1.30 a.m.	Haddock	36	..	..	
								Gurnard, ...	30	..	..	
		..						Plaice (1), ...	25	..	..	
		..						,, (2), ...	90	..	..	
								,, (3), ...	80	..	..	
								,, (4), ...	100	..	..	
									—295	..	..	
								Brill, ...	4	..	..	
								Com. Dab, ...	34	..	..	
								Thornback, ..	6	..	..	
									405	..	..	
15. Same Place.	Oct. 7.	..	..	..	5 to 12	1.45 a.m.	6.0 a.m.	Haddock (1), ..	26	8	34	25 Ink-fish.
								Gurnard, ...	60	29	89	
								Plaice (1), ...	15	..	..	
								,, (2), ...	202	..	..	
								,, (3), ...	480	..	..	
								,, (4), ...	725	..	..	
									—1422	97	1519	
								Brill, ...	4	..	4	
								Lemon Sole, ..	5	..	5	
								Com. Dab, ...	20	598	618	
								Thornback, ..	7	..	7	
								Angler, ...	..	6	6	
									1544	738	2282	
16. Same Place.	Oct. 7.	..	..	..	5 to 14	6.50 a.m.	11.30 a.m.	Cod, ...	14	..	14	
								Codling, ...	90	..	90	
								Haddock (1), ..	115	..	..	
								,, (2), ..	20	..	..	
								,, (3), ..	35	..	..	
									—170	19	189	
								Whiting, ...	7	4	11	
								Gurnard, ...	45	21	66	
								Plaice (1), ...	53	..	..	
								,, (2), ...	158	..	..	
								,, (3), ...	358	..	..	
								,, (4), ...	649	..	..	
									—1218	117	1335	
								Brill, ...	3	..	3	
								Lemon Sole, ..	17	2	19	
								Com. Dab, ..	41	187	228	
								Angler, ...	..	2	2	
									1605	352	1957	
17. Same Place.	Oct. 7.	..	..	..	5 to 13	12.25 p.m.	5.0 p.m.	Cod, ...	1	..	1	There were 11½ baskets of Plaice, 7 of Haddocks, 1 of Codling, and 1 of Gurnard.
								Codling, ...	85	20	105	
								Haddock (1), ..	367	..	..	
								,, (2), ..	39	..	..	
								,, (3), ..	135	..	..	
									—541	..	541	
								Gurnard, ...	76	50	126	
								Plaice (1), ...	31	..	..	
								,, (2), ...	215	..	..	
								,, (3), ...	383	..	..	
								,, (4), ...	487	..	..	
									—1116	200	1316	
								Lemon Sole, ..	5	..	5	
								Com. Dab, ..	17	676	693	
								Thornback, ..	12	..	12	
									1853	946	2799	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
18. Same Place.	1902. Oct. 7.	..	..	.	7 to 13	5.50 p.m.	6.35 p.m.	Codling, ...	6	6	12	Net caught on bottom, and when hauled was found to be torn.
								Haddock (1), ..	5	..	5	
								Gurnard, ...	5	5	10	
								Plaice (1), ...	7	..	..	
								,, (2), ...	61	..	..	
								,, (3), ...	110	..	..	
								,, (4), ...	136	..	..	
									—314	38	352	
								Brill, ...	2	..	2	
								Lemon Sole, ..	2	..	2	
								Com. Dab, ..	..	123	123	
									334	172	506	
19. Dornoch Firth, off Dunrobin.	Oct. 7.8.	..	..	..	,,	8.30 p.m.	12.45 a.m.	Codling, ...	..	1	1	
								Haddock (1), ..	19	..	19	
								Gurnard, ...	45	7	52	
								Plaice (1), ...	7	..	..	
								,, (2), ...	206	..	..	
								,, (3), ...	248	..	..	
								,, (4), ...	468	..	..	
									—929	62	991	
								Lemon Sole, ..	3	..	3	
								Com. Dab, ...	..	678	678	
								Thornback, ..	6	..	6	
									1002	748	1750	
20. Same Place.	Oct. 8.	..	.	..	,,	2.30 a.m.	7.0 a.m.	Haddock (1), ..	6	..	6	
								Gurnard, ...	56	15	71	
								Plaice (1), ...	14	..	..	
								,, (2), ...	225	..	..	
								,, (3), ...	361	..	..	
								,, (4), ...	609	..	..	
									—1209	250	1459	
								Brill, ...	12	..	12	
								Lemon Sole, ..	2	..	2	
								Com. Dab, ..	70	978	1048	
								Thornback, ..	7	..	7	
								Angler, ...	..	7	7	
									1362	1250	2612	
21. Same Place.	Oct. 8.	..	..	..	,,	8.15 a.m.	12.15 p.m.	Cod, ...	8	..	8	The catch included 18 baskets of Haddocks, 9 of Plaice, 1½ of Codlings, and 1 of Gurnards.
								Codling, ...	103	..	103	
								Haddock (1), ..	936	..	..	
								,, (2), ..	160	..	..	
								,, (3), ..	318	..	..	
									—1414	12	1426	
								Whiting, ...	9	7	16	
								Gurnard, ...	76	.	76	
								Plaice (1), ...	35	..	..	
								,, (2), ...	212	..	..	
								,, (3), ...	190	..	..	
								,, (4), ...	925	..	..	
									—1362	87	1449	
								Brill, ...	2	..	2	
								Lemon Sole, ..	5	..	5	
								Com. Dab... ..	80	643	723	
								Thornback, ..	6	..	6	
									3065	749	3814	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
22. Same Place.	1902. Oct. 8.	..	..	..	6 to 14	1.15 p.m.	5.45 p.m.	Cod, ...	2	..	2	
								Codling, ...	27	12	39	
								Haddock (1), ..	156	..	..	
								,, (2), ..	15	..	..	
								,, (3), ..	30	..	..	
									—201	3	204	
								Whiting, ...	..	1	1	
								Gurnard, ...	192	..	192	
								Plaice (1), ...	100	..	..	
								,, (2), ...	119	..	..	
								,, (3), ...	294	..	..	
								,, (4), ...	508	..	..	
									—1021	235	1256	
								Lemon Sole, ..	3	..	3	
								Com. Dab,.. ..	71	590	661	
								Thornback, ..	2	..	2	
								Angler, ...	..	4	4	
									1519	845	2364	
23. Off Tarbet Ness.	Oct. 9.	..	..	..	9 to 20	4.20 a.m.	9.0 a.m.	Codling, ...	102	4	106	
								Haddock (1), ..	60	..	..	
								,, (2), ..	40	..	..	
									—100	..	100	
								Gurnard, ...	101	17	118	
								Plaice (1), ...	53	..	..	
								,, (2), ...	119	..	..	
								,, (3), ...	366	..	..	
								,, (4), ...	615	..	..	
									—1153	92	1245	
								Brill, ...	3	..	3	
								Lemon Sole, ..	4	..	4	
								Com. Dab,.. ..	20	370	390	
								Thornback, ..	5	..	5	
									1488	483	1971	
24. Tarbet Ness, bearing W.S.W.	Oct. 9.	..	..	..	19to25	10.5 a.m.	1.25 p.m.	Cod, ...	3	..	3	
								Codling, ...	20	..	20	
								Haddock (1), ..	67	..	..	
								,, (2), ..	30	..	..	
								,, (3), ..	40	..	..	
									—137	9	146	
								Whiting, ...	5	5	10	
								Ling, ...	2	..	2	
								Gurnard, ...	50	..	50	
								Plaice (1), ...	24	..	..	
								,, (2), ...	74	..	..	
								,, (3), ...	20	..	..	
								,, (4), ...	101	..	..	
									—219	23	242	
								Lemon Sole, ..	14	..	14	
								Com. Dab, ..	..	139	139	
								Thornback, ..	2	1	3	
									452	177	629	
25. Aberdeen Bay, off Newburgh.	Oct. 9-10	..	..	..	5 to 12	11.45 p.m.	4.0 a.m.	Codling, ...	1	..	..	"Offal" consisted of three baskets.
								Haddock (1), ..	¾ bskt.	..	..	
								,, (3), ..	21 ,,	..	..	
									21¾ ,,	..	..	
								Whiting, ...	20	..	..	
								Plaice (1), ...	..	..	..	
								,, (2), ...	3 bskts.	..	..	
								,, (3), ...	2 ,,	..	..	
								,, (4), ...	2 ,,	..	..	
									7 ,,	..	..	
								Com. Dab,.. ..	1 ,,	..	..	
								Brill, ...	1	..	..	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Notal No.	
26. Same Locality.	1902. Oct. 10.	..	..	..	4 to 12	4.35 a.m.	9.45 a.m.	Codling, ...				
								Haddock (1), ..	3	10	13	
								,, (2), ..	10	..	..	
								,, (3), ..	..	..	..	
									1522	..	..	
								Whiting, ...	—1532	23	1555	
								Gurnard	2	7	9	
								Plaice (1).	30	..	30	
								,, (2), ...	..	..	..	
								,, (3), ...	228	..	..	
								,, (4), ...	341	..	..	
									270	..	..	
								Brill, ...	—839	109	948	
								Com. Dab,.. ..	3	..	3	
									210	235	445	
									2619	384	3003	
27. Same Locality.	Oct. 10.	..	..	..	5 to 10	10.20 a.m.	3.20 p.m.	Haddock (1), ..	14	..	..	Unmarketable "offal" consisted of 1½ baskets, chiefly Dabs.
								,, (2), ..	..	..	..	
								,, (3), ..	1558	..	..	
									—1572	..	..	
								Gurnard, ...	23	..	..	
								Plaice (1), ...	12	..	..	
								,, (2), ...	372	..	..	
								,, (3), ...	223	..	..	
								,, (4), ...	210	..	..	
									—817	..	..	
								Brill, ...	2	..	..	
								Com. Dab,.. ..	160	..	..	
									2574	..	..	

EXPLANATION OF PLATE I.

Chart of the North Sea, showing the areas of different depths—(1) up to 20, (2) between 20 and 30, (3) from 30 to 50, (4) from 50 to 100 fathoms, and (5) over 100 fathoms.

Hg. = Herring; M. = Mackerel; L. = Lythe; S. = Sturgeon.

The black spots show the localities where special trawlings have been made, as follows:—

I.—August 31, September 4, 1900; II.—16–19 October, 1900; III.—May 15, 1901; IV.—May 16, 1901; V.—May 17, 1901; VI.—May 19–22, 1901; VII.—December 11, 1901; VIII.—March 10, 1902; IX.—May 23–28, 1902; X.—May, June, 1902.


THE SEA OF NORWAY
NORWAY
NORTH SEA
SCOTLAND
ENGLAND
DENMARK
JUTLAND
HANOVER
OLDENBURG
NETHERLANDS
BELGIUM
FRANCE
DOGGER BANK
NORTHLAND ISLANDS
BERGEN
STAVANGER
CHRISTIANSAND
SKAGENBAR
BOHUS BAY
HOLSTEIN
N.byE
NNE
NE
NEbyE
ENE
EbyN
E
EbyS
ESE
SEbyE
SE
SEbyS
SSE
S
SSW

II.—ON SOME NEW AND RARE CRUSTACEA COLLECTED AT VARIOUS TIMES IN CONNECTION WITH THE INVESTIGATIONS OF THE FISHERY BOARD FOR SCOTLAND.

By Thomas Scott, LL.D., F.L.S., Mem. Zool. Soc. de France.

(Plates II.–VI.)

Though the larger, or, as they are sometimes called, the higher Crustacea of the British seas are now fairly well known, our knowledge of the smaller forms is still very defective; and as these smaller species constitute an important part of the food of small and young fishes, their study becomes important from a fisheries' point of view as well as from the point of view of the naturalist.

A large number of gatherings of small crustaceans has been examined during the past year. These gatherings have been collected at various times, and some of them several years ago; some of the earlier gatherings were not examined or only partially examined at the time they were collected, as other work requiring more immediate attention had to be done. The re-examination of these collections has yielded several new forms, besides a number of rare and interesting species already described. The new species all belong to the Copepoda—a group which from their great abundance, their wide distribution in all our seas and estuaries, and their nutritive qualities, is of immense value as food for fishes.

In a recent paper on the food of fishes* it is shown that the young of almost all the food-fishes live very largely on small crustaceans, and a considerable proportion of them belong to the Copepoda.

Among the species recorded in the present paper the following appear to be undescribed :—

Ameira pusilla, T. Scott (sp. nov.).
„ *ambigua*, T. Scott (sp. nov.).
Delavalia minutissima, T. Scott, (sp. nov.).
Tetragoniceps pygmæus, T. Scott (sp. nov.).
Laophonte gracilis, T. Scott (sp. nov.).
Cletodes neglecta, T. Scott (sp. nov.).
Enhydrosoma gracile, T. Scott (sp. nov.).
Enhydrosoma minutum, T. Scott (sp. nov.).
Dactylopus littoralis, T. Scott (sp. nov.).
Dactylopus vararensis, T. Scott (sp. nov.).
Dactylopus mixtus, T. Scott (sp. nov.).
Paranthessius dubius, T. Scott (gen. et sp. nov.).

While among the other species recorded in the sequel there are severa that are of special interest. For example, *Parastephos pallidus* (G. O. Sars) is a copepod new to the British fauna.

Eucalanus crassus, Giesbrecht, is a copepod which was added to the British fauna a few years ago, and is now recorded from a new station.

Stephos scotti, G. O. Sars, is also recorded from a new station, and the male is described for the first time from Scottish specimens.

* *Twentieth Annual Report Fishery Board for Scotland*, Part III., pp. 486-538 (1902).

The number of Crustacea described in the present paper is scarcely so large as in some of those previously published.

I am, as formerly, indebted to my son Mr. Andrew Scott, A.L.S., for the drawings required to illustrate the new and rare species described here; and the arrangement of the species is similar to that adopted in previous papers.

CRUSTACEA.

Sub-Class ENTOMOSTRACA.

Order I.—COPEPODA.

Calanoida.

Genus *Eucalanus.*

Eucalanus crassus, Giesbrecht.

1881. *Eucalanus crassus*, Giesb., Atti. Acc. Lincei Rend., ser. 4, vol. 4, lem. 2, p. 333. *See also* Pelagisch. Copep. Golfes von Neapel, pp. 131–152, t. 11 and 35.

Several specimens of this species were captured about 10 miles off Aberdeen on November 6th, 1901. This is the first time that *Eucalanus crassus* has been taken so far south on the east side of Scotland. The species has been several times captured in the Moray Firth,* and it has also been collected along with *Eucalanus elongatus* about fifty miles south-east of Fair Island.† Dr. R. Norris Wolfenden records it from the Faröe Channel, where he has also taken several other interesting species.‡

Genus *Stephos*, T. Scott (1892).

Stephos scotti, G. O. Sars. Pl. ii., figs. 1–4.

1897. *Stephos gyrans*, T. Scott (not Giesbrecht), 15th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 146, pl. iv., fig. 9; pl. iii., figs. 17–18.

1892. *Stephos scotti*, G. O. Sars. An Account of the Crustacea of Norway, vol. iv., p. 63, pl. xliii.

This species was first observed in some material dredged in 1896 in Loch Gair—a small lagoon opening into Loch Fyne. Only a single female was obtained on this occasion, and, as it had a somewhat close resemblance to *Stephos gyrans*, Giesbrecht, it was ascribed to that species. Additional female specimens were subsequently obtained not only in other parts of the Clyde area but also in the Firth of Forth, but till quite recently no males had been observed among Scottish specimens. Prof. G. O. Sars, however, had already obtained both sexes of the species in Norwegian waters, and had found that the males especially differed considerably from the males of *Stephos gyrans*, and, therefore, in vol. iv. of his great work on the Crustacea of Norway described it under the name given above.

It happened that I had a gathering of small Crustacea which had been collected in 1894 in an old quarry near Granton to which the tide has access during high water. This gathering, which was examined during

* *Eighteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 382 (1900).
† *Nineteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 237 (1901).
‡ *Journ. Marine Biol. Assoc.*, vol. vi., No. 3 (January, 1902), p. 361.

the past summer, was found to contain many copepods, some of them being rare forms; several specimens of *Stephos scotti* were obtained in this gathering, and they included both males and females. The dissections of both species corresponded exactly with Prof. G. O. Sars' description and figures in the work referred to.

The two drawings (pl. ii., figs. 1 and 2) represent an adult female and male from the Granton quarry gathering; the only obvious external difference between them is in the structure of the fifth pair of feet, separate drawings of which are represented by figures 3 and 4. A full description of the species, with drawings, is given by Prof. Sars in the work already mentioned.

Genus *Parastephos*, G. O. Sars (1902).

Parastephos pallidus, G. O. Sars. Pl. ii., figs. 5–10.

1892. *Parastephos pallidus*, G. O. Sars, Crustacea of Norway, vol. iv., p. 65, pl. xliv.

The genus *Parastephos* was recently instituted by Prof. G. O. Sars for a single male specimen of a copepod found many years before at Sjerjehavn, west coast of Norway, in about 100 fathoms, where the bottom was soft and muddy.

During the past summer, while examining a bottom tow-net gathering collected near the head of Loch Fyne in November, 1901, I observed several specimens, both males and females, of this interesting species; but though most of the male specimens were adult, the females, with the exception of one, were more or less immature. The drawings of the male prepared by Prof. G. O. Sars are perfectly characteristic, but the figures given here may be useful to those who have not seen the drawings of the learned author referred to.

The species is a moderately large one, the adult male (fig. 6) is very nearly two millimetres in length, while the adult female (fig. 5) is somewhat larger, being 2·19 mm. (about $\frac{1}{11}$ of an inch). The description of the fifth feet of the male may be best given in Prof. G. O. Sars' own words:—"Last pair of legs in the male largely developed and very asymmetrical, right leg slender and terminating in a strong denticulated claw, left leg much coarser, with the antepenultimate joint the largest' (fig. 10). The distal portion of the right leg can apparently be folded completely back upon the proximal portion as shown in the figure.

The female antennules resemble those of the male; they are equally elongated and composed of twenty-four joints, the second and eighth joints are each nearly as long as the combined lengths of the two joints which immediately follow them. The antennules are only sparingly setiferous, and are furnished with several small sensory filaments (fig. 7). The fifth pair in the female appear also to be asymmetrical; in the only adult specimen obtained the left leg of the fifth pair is considerably longer than the right one, but this appears to be the only difference (fig. 9).

In the female, each of the first three abdominal segments expands posteriorly into a ridge which is fringed with fine hairs, as shown in fig. 2.

In the adult male represented by the drawing, the second pair of thoracic feet (fig. 8) are alike on both sides, the outer branches being both three-jointed and the inner two-jointed. Prof. G. O. Sars, in his description of the only male specimen he had, states that the outer branch of the right foot of the second pair was only two-jointed; but such a difference is rather unusual among the Calanoida, and probably his specimen may

have been defective, as no such difference was observed in Clyde specimens. The Clyde is, so far, the only known British habitat for this interesting species.

Genus *Pseudophœnna*, G. O. Sars (1900).

Pseudophœnna? typica, G. O. Sars. Pl. ii., figs. 11–15.

1902. *Pseudophœnna typica*, G. O. Sars. An Account of the Crustacea of Norway, vol. iv., p. 44, pl. xxix., xxx.

A single male specimen of a Calanoid, which I have referred, though somewhat doubtfully, to *Pseudophœnna typica*, G. O. Sars, was obtained in a bottom tow-net gathering of Crustacea collected last year near the head of Loch Fyne. The specimen agrees very closely with *Pseudophœnna typica* in its general outline and in the structure of the various appendages so far as these can be made out, except that the fifth feet slightly differ from the drawing given in the work of Prof. G. O. Sars referred to above, but not so much in their general structure as in the apical part of the right leg (fig. 15).

This Loch Fyne specimen measures fully one and a half millimetres; the thorax is moderately stout, but the abdomen is slender (figs. 11 and 12). The antennules, which reach to about the distal end of the thorax, appear to be composed of twenty-one joints. The basal joints, from the third to the seventh, are shorter than the others; the right is elongated and appears to be indistinctly articulated near the distal end. The antennules are only sparingly setiferous, but they are well supplied with sensory filaments as shown in the drawing (fig. 13). The species will not be satisfactorily determined till more specimens of both sexes are obtained.

In his note on the distribution of this Calanoid, Sars states that he has obtained it at several places, from Christiania Fjord to Vardö, and that it is a true bottom form, it is therefore probable that the species may not be rare in the deeper water off the Scottish coast.

Genus *Pseudocyclops*, G. S. Brady (1872).

Pseudocyclops obtusatus, Brady and Robertson. Pl. vi., figs. 13–15.

1873. *Pseudocyclops obtusatus*, B. and R., Ann. and Mag. Nat. Hist. (4), vol. xii., p. 128, pl. viii., figs. 4–7.

1878. *Pseudocyclops obtusatus*, Brady, Mon. Brit. Copep., vol. i., p. 84, pl. xii., figs. 1–13.

Although the distribution of this species seems to be extensive, it does not appear to be anywhere very common. The female represented by the drawing (fig. 13) was obtained during the past summer by washing the filters at the Hatchery, Bay of Nigg. The species, which is fairly well marked, has been described by Brady and Robertson in the Annals and Magazine of Natural History, and by Prof. G. S. Brady in his Monograph of the British Copepoda.

In this species the rostrum is of a somewhat broadly triangular form and the antennules (fig. 14) are short and moderately stout, and are apparently composed of seventeen joints and are furnished with numerous plumose setæ; the basal joint also carries two moderately long sensory filaments.

The outer branches of all the thoracic feet are armed with stout dagger-like spines on their outer aspect. The inner branches of the fifth pair are considerably shorter than the outer ones, and the end joints terminate abruptly, as shown in the figure; moreover, the marginal setæ on the

inner edges of both the inner and outer branches have the basal half distinctly thicker than the distal portion, so much so as to be observable without dissection (fig. 15).

This species has also been obtained in the Moray Firth and in the Firth of Forth as well as in the Clyde, but seldom more than one or two specimens have been noticed in any single gathering.

Genus *Labidocera*, Lubbock (1853).

Labidocera wollastoni, Lubbock.

1857. *Pontella wollastoni*, Lubb., Ann. Nat. Hist. (2), vol. 20, p. 406, pl. 10, 11.

This somewhat rare species was captured in Loch Fyne with the surface tow-net at Station XIII. (off Largymore), October 9, 1901. It also occurred in a bottom tow-net gathering collected at Station XIII., near the mouth of the Clyde estuary, on November 11, 1901. In the gathering at Station VIII. there were also obtained *Candacia pectinata*, *Metridia lucens*, *Parapontella brevicornis*, and other forms.

Fam. Harpacticidæ.

Genus *Ectinosma*, Boeck (1864).

Ectinosma curticorne, Boeck. Pl. vi., fig. 1.

1885. *Ectinosoma curticorne*, Boeck, Abhandl. Natur. Vereins zu Bremen, ix. Bd., p. 194, t. vi., figs. 1–12.

1895. *Ectinosoma curticorne*, T. and A. Scott, Trans. Linn. Soc., vol. vi. (Zool.), p. 430, pl. 36, figs. 22, 30, 34, *et. seq.*

This is a marine species, and though recorded from several British localities it does not appear to be anywhere very common; it is, however, more frequently met with amongst the fronds and roots of algæ in the littoral zone than in off-shore waters. It is usually of a brownish colour, and there is also usually a dark-coloured blotch at the bases of the antennules, such as is observed in *Bradya minor*, but in that species the outline of the blotch is more distinctly defined. Specimens of this species have been obtained in gatherings collected some years ago in shallow water near Musselburgh and Granton, Firth of Forth, but which have only recently been examined. In this species, as in one or two others, the furcal joints are each provided at the apex with a short but stout cone-shaped spine and with two other short setæ which are moderately stout and spiniform, as shown in the drawing (pl. vi., fig. 1). There are also, as in other Harpactids, one or two elongated terminal setæ, the principal of which is moderately stout.

A few other *Ectinosomas* were obtained in the Musselburgh gatherings along with *E. curticorne*, two of which may be referred to here, viz. *E. gracile* and *E. herdmani*. *Ectinosoma gracile*, T. and A. Scott, is a small and slender form which was first discovered near St. Monans, Firth of Forth, and has since been found sparingly in several British localities. This species was moderately frequent in one of the gatherings from Musselburgh. *Ectinosoma herdmani*, T. and A. Scott, though a larger form than the last, is also moderately slender, and was also first observed near St. Monans. Most of the *Ectinosomas* require careful examination, but this is one of a few that are comparatively easily identified. This species was one of the more common Harpactids in the Musselburgh gatherings; it is readily noticed by its elongated slender form and the opaque white colour it assumes when preserved in spirit.

Genus *Ameira*, Boeck.

Ameira pusilla, T. Scott, sp. nov. Pl. v., figs. 1–10.

Description of the Female.—Body elongated and slender, resembling generally a small *Canthocamptus* or *Attheyella*; length about three and a half millimetres (about $\frac{1}{7\,0}$ of an inch), rostrum short (fig. 1).

The antennules are only moderately elongated and composed of seven joints, the second joint is considerably longer than any of the others, and the antepenultimate one is apparently the smallest, as shown by the drawing (fig. 2).

The antennæ, which are moderately stout (fig. 3), are furnished with a small uniarticulated secondary branch.

The mandibles are of a narrow cylindrical form and are armed with several small teeth or spinules on the obliquely truncate apex; the palp is of moderate size and is composed of a somewhat dilated basal joint bearing two small one-jointed branches (fig. 4).

The second maxillipeds are small, two-jointed, and armed with a small but moderately stout terminal claw (fig. 5).

In the first pair of thoracic feet the inner branches, which are three-jointed, are very long, but this is owing to the elongation of the first and third joints, the middle joint being a short one, the first joint reaches to about the extremity of the three-jointed outer branches, while the third joint is fully half the length of the first and twice the length of the second joint; the inner branches are also slender in proportion to the length (fig. 6).

The inner branches of each of the following three pairs are all shorter than the outer ones, which are somewhat elongated, and both branches in all the three pairs, and especially of the third and fourth, are moderately slender (figs. 7 and 8).

In the fifth pair the inner produced portion of the basal joint is broadly sub-cylindrical, and does not reach to the end of the secondary joint; it appears to be provided with four apical setæ, the two inner ones being moderately short and spiniform, but the two others are longer. The secondary joint is also somewhat cylindrical in form, and rounded at the ends, its breadth being nearly equal to half the length; it appears to be provided with only three apical setæ, arranged as shown in the drawing (fig. 9), the middle one being very long and slender and the inner one also slender and elongated, but the outer is short.

The furcal joints are fully half as long as the last segments of the abdomen, and the principal tail setæ are very long and slender (fig. 10).

Habitat.—Off Musselburgh, Firth of Forth, in shallow water, but not very common.

Remarks.—This species has a close general resemblance to some forms of *Canthocamptus*, not only in its general configuration but also in some of its appendages; this is especially noticeable in the structure of the first thoracic feet, which do not differ much from *Canthocamptus staphylinus* or *C. northumbricus*; this pair is also somewhat similar to those of *Stenhelia ima*, but the terminal joints of the inner branches are proportionally considerably longer. The structure of the antennæ and mandibles shows its relationship with *Ameira*, but it differs in the structure of the first and fifth pairs of thoracic feet from any species previously described, so far as these are known to me.

Ameira ambigua, T. Scott, sp. nov. Pl. v., figs. 11–19.

Description of the Female.—This form, which somewhat resembles *Ameira longipes* in general appearance, is comparatively small; the

specimen represented by the drawing (fig. 11) measures only ·56 mm. (about $\frac{1}{44}$ of an inch). In this form the rostrum is small and the furcal joints short.

The antennules (fig. 12) are elongated and slender and composed of eight joints, the smallest joints counting from the proximal end are the fifth and seventh, while the second is the largest. The proportional lengths of the various joints are shown approximately by the annexed formula :—

Lengths of the joints,	-	15 · 18 · 12 · 11 · 7 · 8 · 5 ·
Numbers of the joints,	-	1 · 2 · 3 · 4 · 5 · 6 · 7 · 8

The antennæ appear to be two-jointed and moderately stout, but the secondary branch is small and composed of a single joint (fig. 13).

The mandibles are very small and of a cylindrical form, the distal end is obliquely truncated and armed with minute spines; the palp is also very small, and has the basal part slightly dilated and provided with a minute one-jointed branch (fig. 14).

The second maxillipeds are moderately stout and two-jointed, and armed with an elongated and slender terminal claw (fig. 15).

The first pair of thoracic feet have the inner branches elongated and moderately stout; the first joint is about three times as long as the entire length of the second and third joints, but these two joints are small and sub-equal. The outer branches are moderately slender, and they are shorter than the first joint of the inner ones (fig. 16).

The next three pairs are all elongated and moderately stout. In the second pair (fig. 17) the inner branches, which are somewhat shorter than the outer, taper towards the distal end, as shown in the drawing, the first joint being more dilated than the second, and the second than the last; each of the three joints is furnished with a slender seta on its inner margin. The outer branches are slender, and the exterior marginal spines are elongated; the second joint is also provided with one, and the third with two slender setæ on the inner edge.

In the fourth pair the inner branches are also, as in the second pair, shorter than the second branches, but they are scarcely so stout as those of that pair; moreover, the first and second joints are each furnished with a seta on the inner margin, while the third bears two setæ. The outer branches do not differ much from the same branches in the second pair (fig. 18).

In the fifth pair the inner produced portion of the basal joint bears four slender setæ on its broadly rounded apex, the second one from the inside being much longer than the others. The secondary joints are sub-cylindrical in general form, but with the ends rounded; they are each about twice as long as broad and carry five setæ round the outer margin and apex, but the two innermost are considerably longer than the others (fig. 19).

Habitat.—Off Musselburgh, Firth of Forth; apparently rare.

Remarks.—This is one of those troublesome forms which, while differing in one or other of its structural details from any of the described species I am acquainted with, yet exhibits no single character prominently distinctive, such as we have in *Ameira longicaudata*, T. Scott. The following three characters, however, taken in combination will, I think, enable this species to be distinguished—(1) the structure of the somewhat slender antennules, (2) the comparatively long first joint of the inner branches of the first thoracic legs, along with the short second and third joints, and (3) the form and armature of the fifth pair in the female. The male has not been observed.

Genus *Delavalia*, G. S. Brady.

Delavalia minutissima, T. Scott, sp. nov. Pl. iv., figs. 3–10.

Description of the Female.—The female of this species resembles the type-form of the genus in its general outline, and also generally in its structural details, but it is the smallest of any species that has yet been described, being scarcely ·4 mm. (about $\frac{1}{67}$ of an inch).

The antennules appear to consist of seven joints; the end joint is about twice as long as the penultimate one, but the others are sub-equal in length, and, as usual, become gradually stouter towards the proximal end (fig. 4).

The antennæ and mouth organs, being so small, were difficult to get hold of, and are not figured, but so far as they could be made out they resembled very closely those of *Delavalia æmula* (T. Scott).

The first pair of thoracic feet resemble in some measure the first pair in *Delavalia robusta*, Brady and Robertson, and of *D. reflexa* of the same authors, but the principal terminal spine of the inner branches is distinctly different, and the spine on the inner distal angle of the second basal joint is remarkably elongated, as shown by the figure (fig. 5).

The next three pairs (figs. 6 to 8) resemble those of *Delavalia æmula*, but are more slender and moderately elongated, and while in the second and third pairs the outer and inner branches are of nearly equal length, the outer branches of the fourth pair are considerably longer than the inner, as shown by figure 8.

The fifth pair, though small, are, in their general character, similar to those of the group to which the species belongs. The basal joint is furnished with four setæ on the broadly truncate apex; a short and a long seta near its inner aspect and a pair somewhat similar towards its exterior aspect, with a distinct space between the two pairs; the secondary joints are each armed with four setæ on the broadened, truncated end, the two middle setæ being much smaller than the others, as shown by the drawing (fig. 9).

The caudal segments are proportionally more elongated and slender than those of any other of the described species of the genus; these segments, besides being very narrow, are at least equal to the entire length of the last two segments of the abdomen (fig. 10).

Habitat.—Moray Firth; apparently rare. No males have been observed.

Remarks.—What first attracted my attention towards this species was its small size and the remarkable length of the furcal joints. It is the smallest species of the group that I have yet observed, and though apparently rare, that may be partly accounted for by its being so easily overlooked. The specimen from which the figures have been prepared was obtained in a gathering of dredged material collected in the Moray Firth several years ago, but the description of it was delayed in the hope that other specimens might turn up, which would have enabled me to present a more complete series of detail drawings, but this hope has not yet been realised. The description and figures given here are, however, along with the small size of the copepod, sufficient to distinguish it from those already described, indeed, its extremely long furcal joints would alone mark it out as different, and these taken along with the peculiar armature of the inner branches of the first thoracic feet, and also of the fifth pair, give to the species a character distinct from other *Delavalias*.

Canthocamptus.

Canthocamptus inconspicuus, T. Scott.

1900. *Canthocamptus inconspicuus*, T. Scott, 18th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 390, pl. xiv., figs. 1–8.

This small Harpactid was obtained in a gathering of Entomostraca collected off Musselburgh in 1894, but only recently examined: this is the first time it has been obtained in the Firth of Forth, and it has only previously been recorded from the Moray Firth. *Canthocamptus inconspicuus* somewhat resembles *C. parvus*, T. and A. Scott, in general appearance, and like that species it has antennules composed of six joints; but it differs in several particulars, and one of the more obvious differences is the longer furcal joints, and by this character alone it can be distinguished from *E. parvus*.

Canthocamptus parvus, T. and A. Scott.

1896. *Canthocamptus parvus*, T. and A. Scott, Ann. Nat. Hist. (6), vol. xviii., p. 6, pl. ii., figs. 14–22.

This species has recently been obtained in several gatherings, one of which consisted of small Crustacea collected in the pond at the Sea-fish Hatchery, Bay of Nigg, June 25, 1902. Like the *Canthocamptus* previously mentioned, this one usually occurs very sparingly in any single gathering, but it has apparently a wider distribution, and has been observed not only at different times in the Firth of Forth, where it was first discovered, but also in the Moray Firth and in the Firth of Clyde. In this species the furcal joints are very short, and it thus differs from *C. inconspicuus*. *C. parvus* is usually found near the shore about the roots of algæ, and especially where there is a muddy bottom.

Genus *Neobradya*, T. Scott.

Neobradya pectinifer, T. Scott.

1892. *Neobradya pectinifer*, T. Scott, 10th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 249, pl. xiii., figs. 19–32.

A single specimen of this rare species occurred in a gathering of small Crustacea collected at the north end of Inchkeith, on November 15th, 1889, but not examined till October, 1902. The species was first observed among some dredged materials collected off St. Monans, and it was afterwards obtained in the Firth of Clyde,* but though its distribution appears to be somewhat extensive, I have only rarely observed it.

Genus *Tetragoniceps*, G. S. Brady.

Tetragoniceps pygmæus, T. Scott, sp. nov. Pl. iv., figs. 11–19.

Some time ago, when re-examining a gathering of small Entomostraca collected near Musselburgh in 1894, I observed odd specimens of a slender copepod very like *Tetragoniceps incertus*, T. Scott—a species described in the Tenth Annual Report of the Fishery Board for Scotland—but rather smaller than that form, and the fact that one or two of them were provided with ovisacs showed that their smaller size could not be ascribed to immaturity, but on account of their likeness to the species named they

* Brit. Assoc. Handbook on the Natural History of Glasgow and the West of Scotland (1901), p. 353.

had probably on previous examinations been passed over as being merely a form of it. Recently, however, a more careful scrutiny of these smaller forms has revealed certain structural differences which render their removal from that species necessary, and as this form is distinctly smaller than the other, I propose to call the new species *Tetragoniceps pygmæus*, and the following is a description of it :—

Description of the Female.—The female closely resembles the female of *Tetragoniceps incertus* but is distinctly smaller, measuring only a little over ·5 mm. (about $\frac{1}{47}$ of an inch). (*Tetragoniceps incertus* is about one millimetre in length). The body is very slender, with a small but distinct rostrum (fig. 11).

Antennules almost similar to those of *Tetragoniceps incertus*, differing only to a small degree in the proportional lengths of the different joints (fig. 12). The antennæ and mouth organs are also very similar.

The first four pairs of thoracic feet are also very similar to the same appendages in *Tetragoniceps incertus*, but the first pair are rather more slender, especially the inner branches, while the seta on the inner margin of the first joint appears to be situated nearer the middle of it, the outer branches appear also to be proportionally rather longer (fig. 14).

The fifth pair (fig. 16) are not only smaller, but differ in form and armature ; they are more bluntly rounded at the apex, and instead of terminating in a single stout apical spine as in the species referred to, there is at the base of the larger spine another one, small but distinct ; the arrangement of the supplementary setæ is also different in the two species, as shown by the drawings.

The furcal joints, which are somewhat dilated in the middle, taper towards the distal end ; the principal apical seta of each furcal joint is moderately short, and the outer portion of it terminates somewhat abruptly, but is continued by a slender portion which forms a peculiar loop where the two portions join, as indicated by the figure ; this peculiarity is not found in *Tetragoniceps incertus* (fig. 19).

The male resembles the female, except in the following particulars. The antennules (fig. 13) are modified for grasping, they differ slightly from the male antennules in *Tetragoniceps incertus*.

The inner branches of the third pair of thoracic feet (fig. 15) are small and three-jointed ; the first and second joints are very short, but the inner part of the second is produced into a long bent spiniform process which extends considerably beyond the extremity of the branch ; the last joint is also small and bears a minute terminal spine. In *Tetragoniceps incertus* this branch has a long straight process arising from its inner basal aspect and is furnished with two terminal setæ.

The fifth pair are smaller than those of the female, they also differ in their armature as shown by the drawing (fig. 17). The supplementary foot on the first abdominal segment is furnished with three setæ (fig. 18).

Remarks.—This form, though perhaps it does come somewhat near to *Tetragoniceps incertus*, is not difficult to distinguish from that species, even without dissection, by its smaller size and by the difference in the character of the fifth feet and the furcal joints, and these differences are of course more easily observed when one has both forms under observation.

Genus *Laophonte*, Philippi (1840).

Laophonte gracilis, T. Scott, sp. nov. Pl. vi., figs. 6–12.

Description of the Female.—The body is slender and sub-cylindrical, and appears to be covered with exceedingly minute hairs. It has a small blunt rostrum, and the furcal joints are scarcely so long as the last

abdominal segment (fig. 6). Length about ·67 mm. (about $\frac{1}{39}$ of an inch). The antennules (fig. 7) are short and composed of seven joints; the first three joints are moderately large, but the others are small.

The antennæ and mouth organs are not unlike those of *Laophonte intermedia*, except that the second maxillipeds are long and narrow, and the terminal claw very slender and elongated (fig. 8).

The first pair of thoracic feet are slender, and the first joint of the inner two-jointed branches is elongated and narrow, but the second joint is short and armed with a moderately stout terminal claw; the inner branches are three-jointed, and just about half as long as the first joint of the inner branches (fig. 9).

The second, third, and fourth pairs, which are somewhat similar to each other in structure, are also slender. The fourth pair is represented by the drawing (fig. 10). In this the outer branches are of moderate length, and composed of three sub-equal joints, but the inner branches are short and two-jointed, the first joint being a small one.

The fifth pair (fig. 11) are comparatively large and foliaceous, and have a general resemblance to those of *Laophonte similis*; the basal joint, which is sub-triangular in outline, is produced interiorly so that its apex reaches to about the middle of the secondary joint; there are three stout setæ on the inner margin of the basal joint and two smaller apical setæ. The secondary branch is sub-ovate, somewhat longer than broad, and provided with about five setæ on the lower half of the outer margin and apex, the second seta from the inside is of moderate length, but the others are short. One ovisac with several small ova.

Habitat.—In an old quarry at Granton into which the tide ebbs and flows. Rare. This is different from any species known to me.

The following other species of *Laophonte* were also found in the same gathering with the species just described:—

Laophonte littorale, T. Scott.
Laophonte intermedia, T. Scott.
Laophonte hispida (Brady and Robertson).
Laophonte thoracica, Boeck.
Laophonte inopinata, T. Scott.
Laophonte curticauda, Boeck.

Laophonte lamellifera (Claus).

1863. *Cleta lamellifera.* Die frei-lebenden Copepoden, p. 123, t. xv., figs. 21–25.

This fine species occurred sparingly in a gathering of copepods washed from some dredgings collected in shallow water off Musselburgh, Firth of Forth. In the same gathering, as well as in another from near the same place, collected by means of a hand-net, between tide marks, another *Laophonte*, *L. intermedia*, T. Scott,* was much more frequent, and as it somewhat resembles *L. lamellifera* might be mistaken for it, but *L. intermedia* has shorter furcal joints, and the outer branches and second basal joint of the first pair of thoracic feet have a dense covering of minute hairs, which may frequently be seen without dissection.

Laophonte denticornis, T. Scott.

1894. 12th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 246, pl. vii., figs. 13–23.

One or two specimens of this species were found in the same gathering

* *Thirteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 168. figs 10-20 (1894).

with the last; it is a rare form, and has not hitherto been observed on the south side of the Forth. *Laophonte denticornis* differs from *L. serrata*, Claus, in having the outer branches of the first thoracic feet three-jointed, and in the different form of the fifth feet in both the male and female; the female also wants the posterior dorsal spine which is characteristic of the female of *L. serrata*. *Laophonte hispida* and *thoracica* were also obtained in this Musselburgh gathering.

Genus *Laophontodes*, T. Scott (1894).

Laophontodes typicus, T. Scott.

1894. *Laophontodes typicus*, T. Scott. 12th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 249, pl. viii., figs. 2–8.

This species, which is not difficult to identify, even without dissection, by the peculiar form of the fifth thoracic feet in the female, was moderately frequent in the gathering from the old quarry at Granton in which *Stephos scotti* was obtained.

Genus *Cletodes*, G. S. Brady (1872).

Cletodes neglecta, T. Scott, sp. nov. Pl. iv., figs. 20–31.

Description of the Female.—Body elongated, narrow, cylindrical; all the segments distinct except the first and second of the abdomen, which are slightly coalescent. The first three segments of the abdomen have their lateral angles produced into small spiniform processes. Rostrum short and broadly triangular. Caudal joints narrow and elongated and equal to nearly one and a half times the length of the last abdominal segment (fig. 20).

The antennules are short and stout and composed of five (or six) joints; the end joint is narrower and rather longer than the others, while the penultimate one is very small; the last four joints are also all setiferous, as shown by the drawing (fig. 21).

Antennæ two-jointed and of moderate length; the end joint is provided with spiniform, marginal and terminal, setæ; a few of the terminal setæ are elongated, but the others are moderately short. The secondary branches of the antennæ are rudimentary, and are represented by a single short hair as in *Cletodes limicola*, G. S. Brady (fig. 23).

The mandibles are stout, elongated, sub-cylindrical, and armed with a few stout apical teeth. The palp is composed of a single one-jointed branch, and is provided with several plumose setæ (fig. 24).

The second maxillipeds are composed of two moderately slender joints, and the terminal claw is also slender and elongated (fig. 25).

The first pair of thoracic feet (fig. 26) resemble in their structure and armature the first pair in *Cletodes limicola*; both branches are short, but the three-jointed outer branches are rather longer than the two-jointed inner ones. In the inner branches the end joint is narrower and about one and a half times longer than the other. Moreover, the seta on the outer angle as well as the one on the inner angle of the second basal joint are both elongated, the inner one being also plumose. In the second pair (fig. 27) the outer branches are elongated and slender, but the inner two-jointed branches are short; the second joint of the inner branches is narrow, and fully twice as long as the first joint; two very long hairs spring from its truncate apex, but otherwise it is unarmed; the outer branches are provided with long slender spines on the exterior distal angles of all the three joints; there is also a single slender seta on the

lower half of the inner margin of the middle joint. The third pair (fig. 28) are somewhat similar to the second, except that they are rather more slender, and that the second joint of the inner branches bears a small spine on the distal end of its outer margin in addition to the two long terminal setæ. The fourth pair, on the other hand, scarcely differ from the third except that the outer branches are rather more elongated (fig. 29).

The fifth pair resemble very closely the fifth pair of the female in *Cletodes limicola*, so much so that, with the exception of the basal joint being rather more produced, the general configuration and armature of this pair are in the two species almost identical (fig. 30).

The male is very similar to the female. The antennules of the male have, as usual, a modified structure (fig 22), and the fifth pair of thoracic feet are very small (fig. 31). In the fifth pair of feet the basal joint is nearly rudimentary, and the secondary joint, which is of a narrow cylindrical form, is provided with only two apical setæ, as shown by the drawing.

Habitat.—Moray Firth; moderately rare.

Remarks.—The form just described has been known to me for a considerable time, but has been left over from year to year, as I was in doubt whether the differences observed were of any real value. As, however, I have not been able to find any described species to which this form could be assigned, I have described it here under a distinct name.

This form belongs to a group of *Cletodes* which are all closely related to each other, and exhibit this relationship by the similarity in the structure of the antennules and of the first pair of thoracic feet, but especially in the structure and armature of the female fifth pair; and perhaps the most typical species of the group is the *Cletodes limicola* of G. S. Brady. In this group the antennules are usually composed of five joints, the penultimate one being very small; in the first pair of thoracic feet both branches are short, but the inner rather shorter than the outer; the second joint of the inner branches is also distinctly narrower and considerably longer than the first joint. In the fifth pair the basal joint is small, and only slightly produced interiorly—sometimes not at all—and provided with few, usually two or three, setæ. The secondary joints, on the other hand, are elongated and narrow and usually furnished with five setæ—two at the apex, one on the lower part of the inner margin, and two widely separated on the outer margin. The form just described, while agreeing in some of its structural details with several members of this group, differs in one point or another from them all, so far as they are at present known to me.

Cletodes propinqua, Brady and Robertson.

1875. *Cletodes propinqua*, B. and R., Brit. Assoc. Report, p. 196.

This curious little Harpactid occurred very sparingly in the same Musselburgh gathering with the *Laophontodes* just referred to. Its bathymetrical distribution appears to extend from the littoral zone down to moderately deep water. The furcal joints are short and pyriform, and seem to be characteristic of the species. One or two other species of *Cletodes*, including *C. limicola*, G. S. Brady,* and *C. lata*, T. Scott,† were also obtained in the same gathering.

* *Nat. Hist. Trans. Northumb. and Durham*, vol. iv., p. 438, pl. xxi., figs. 10-17 (1872).
† *Tenth Annual Report of the Fishery Board for Scotland*, Part III., p. 257, pl. x., figs. 10-18 (1892).

Genus *Enhydrosoma*, Boeck (1872).

Enhydrosoma gracile, T. Scott, sp. n. Pl. ii., figs. 16–26; pl. iii., fig. 1.

Description of the Female. — Body slender, cylindrical, slightly encurved, but otherwise similar to *E. curvatum*, Brady and Robertson (fig. 16). Length of specimen represented by the drawing about ·45 mm. ($\frac{1}{55}$ of an inch).

Antennules very short, moderately stout, and sparingly setiferous; they are composed of four joints, the first three being sub-equal in length, but the last is considerably smaller than any of the others (fig. 17). The formula shows approximately the proportional lengths of the various joints:—

1	2	3	4
22	18	19	11

The antennæ (fig. 18) appear to be somewhat like those of *E. curvatum*.

The mandibles (fig. 19) are also similar to those of the same species.

The second maxillipeds (fig. 20) have basal joint short, but the preceding one is elongated, and the terminal claw is slender and moderately short.

The first thoracic feet are somewhat like those of *C. curvatum*; the inner branches are short and two-jointed, the second joint being only slightly longer than the first, and their extremities, which do not reach to the end of the second joint of the outer branches, bear two elongated slender setæ feathered at the end; the outer branches are three-jointed; the first joint is fully as long as the entire length of the next two, but the end joint is shorter than the second one; each of the three joints is furnished with a moderately long and very slender seta on its outer aspect, while the end one also carries two elongated terminal setæ similar to those on the inner branches (fig. 21).

The second, third, and fourth pairs (figs. 22 and 23), which appear to differ little from each other, have the inner branches very short and composed of two joints, the first being very small, while the end joint is furnished with a few terminal setæ as shown by the figures; the outer branches are three-jointed and of moderate length and stoutness, the middle joint is slightly shorter than the first or third.

The fifth pair are broadly foliaceous, distinctly two-branched, and both branches are broadly sub-truncate at the end and provided with five moderately stout and elongated setæ, the lengths of which vary to some extent as shown in the drawings; a single seta springs from a small lobe near the outer distal angle of the outer branch (fig. 24).

The furcal branches are very short (fig. 26).

The ovisac is small and contains very few ova.

The male appears to differ little from the female except in the structure of the antennules (pl. ii., fig. 1), and also to some extent in the form of the fifth feet. The fifth pair in the male consists of a rectangular plate about half as long as broad, and obscurely divided into two portions; the inner portion is furnished with two moderately elongated setæ on the lower edge, while the outer portion bears three or four setæ as shown by the drawing (pl. i., fig. 25).

Habitat.—Shore at Musselburgh, Firth of Forth; moderately rare.

Remarks.—This species occurred with a number of other curious forms in a gathering collected in 1894. Several other new species were obtained in this gathering, but some of these have already been described.* This

* See *Thirteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 167, *et seq.*; *Ann. and Mag. Nat. Hist.* (6), vol. xv., pp. 52-53; *Ann. Scot. Nat. Hist.*, January, 1895.

Enhydrosoma is a smaller and more slender form than *E. curvatum*; the female antennules are apparently only four- instead of five- jointed, the third and fourth joints in *E. curvatum* being in this species completely coalescent. The first pair of thoracic feet are also somewhat different in the two species, but a greater difference is observed in the structure of the female fifth pair; in *E. curvatum* there is a distinct though small secondary branch, but in the present species the branches, which are sub-equal, do not appear to be distinctly separated.

Enhydrosoma minutum, T. Scott, sp. nov. Pl. iii., fig. 25; pl. vi., figs. 1–5.

Description of the Female.—This is a small but moderately stout species as shown by the drawing (fig. 1, pl. vi.). Its entire length, exclusive of antennules and tail setæ, scarcely reaches to ·4 m.m. (about $\frac{1}{60}$ of an inch).

The antennules (fig. 2, pl. vi.) are composed of five joints, but the fourth is very small; the armature consists of a number of moderately stout setæ, a few of them being plumose, and the end joint carries a stout terminal spine as shown by the figure.

The mouth organs resemble generally those of *E. gracile*, but the second maxillipeds are comparatively rather stouter (fig. 3, pl. vi.).

The first pair of thoracic feet, which appeared to be somewhat similar in structure to the first pair in *E. gracile*, were accidentally damaged, so that a correct drawing of them could not be prepared.

The second, third, and fourth pairs are all somewhat alike in structure (pl. iii., fig. 25; pl. vi., fig. 4), and their outer branches do not differ greatly from the outer branches of the feet similar to them in *E. curvatum*, but the inner branches are very small, they each consist of two joints, the first joint being much shorter than the other, while the end joint tapers towards the distal end, and carries a single elongated terminal seta.

The fifth pair (fig. 5, pl. vi.) are broadly foliaceous and resemble those of *E. gracile*; but the secondary branches are more distinctly articulated to the basal joints, and the setæ of the two joints appear to be stouter.

The furcal joints are extremely short. The female appears to carry one ovisac with several moderately large ova.

Habitat.—Aberdeen Bay, Station V., Nov. 12, 1901. One specimen only.

Remarks.—*Enhydrosoma minutum* differs from the species already described by the difference in the structure of the antennules, and by the form and armature of the inner branches of the second, third, and fourth pairs of feet. No male specimen has been observed.

Enhydrosoma curvatum (Brady and Robertson).

1875. *Rhizothrix curvata*, B. and R., Brit. Assoc. Rept., p. 197.
1880. *Enhydrosoma curvatum*, Brady, Mon. Brit. Copepoda, vol. ii., p. 98, pl. lxxxi., figs. 12–15; pl. lxxxii., figs. 11–19.

This also occurred in the gathering from the old quarry near Granton; it is quite distinct from the two species, *E. gracile* and *E. minutum*, just described; the difference in the structure of the fifth thoracic feet would alone be sufficient to separate them; it is, moreover, a somewhat larger species. There is a previous record of this species from the Forth district, but from a different part of the estuary,* as well as from other places around the Scottish coasts.

* *Eighth Annual Report of the Fishery Board for Scotland*, Part III., p. 319 (1890).

Genus *Nannopus*, Brady (1880).

Nannopus palustris, Brady.

1880. *Nannopus palustris*, Brady, Mon. Brit. Copepoda, vol ii., p. 100, pl. lxxvii., figs. 18-20.
1902. *Nannopus palustris*, T. Scott, 20th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 466, pl. xxiii., figs. 13–25.

This somewhat rare species was observed very sparingly in the gathering from the old quarry near Granton in which several other interesting forms have been obtained, and it also occurred in a hand-net gathering of small Crustacea collected between tide marks at Musselburgh. *Nannopus palustris* appears to be a true littoral or brackish-water species, and is rarely met with in deep water off shore. Another species with a somewhat similar habitat to *Nannopus*, viz. *Palatychelipus littoralis*, G. S. Brady, was also obtained in the vicinity of Musselburgh, where it was observed in 1892,* and was then new to the Scottish coasts. It is now ascertained that the species has a wide distribution, but it does not appear to be anywhere very common.

Genus *Dactylopus*, Claus (1863).

Dactylopus littoralis, T. Scott, sp. nov. Pl. iii., figs. 2–8.

Description of the Female.—Body moderately slender, rostrum short (fig. 2).

Antennules (fig. 3) short and composed of eight joints, the third is shorter than the one which precedes or follows, the fifth and seventh joints are small, while the last is about as long as the combined lengths of the sixth and seventh. The proportional lengths of the various joints are shown approximately by the formula :—

8	11	9	11	4	6	4	9
1	2	3	4	5	6	7	8

The second maxillipeds are stout with a moderately stout terminal claw, a somewhat long spine-like seta springs from the inner aspect and near the distal end of the second joint, but, with the exception of another small hair, this joint appears to be devoid of armature of any kind. The first joint is provided with two or three small spine-like hairs at the distal end, while the end joint is almost as narrow as the base of the terminal claw (fig. 4).

The first pair of thoracic feet are moderately short and stout, the first joint of the inner branches is somewhat longer than the outer branches, but the last two joints are small, and the end one is armed with two terminal spines, one being short and stout, the other longer and setiform; the outer are composed of three sub-equal joints similar to those of the species previously described (fig. 5).

The second, third, and fourth pairs are moderately elongated, but the fourth is rather longer than the others; both branches are three-jointed, and the inner branches are shorter than the outer ones; the marginal spines of the outer branch are moderately long and slender, and the setæ on both branches elongated and plumose (fig. 6 represents the fourth pair).

The fifth pair are moderately broad and foliaceous, especially the outer

* *Tenth Annual Report of the Fishery Board for Scotland*, Part III., p. 205, pl. v., figs. 11-13 (1893).

or secondary joints; these joints, which are of an ovate form and about one and a half times as long as broad, bear five setæ round the lower outer margin and end, the middle one being rather longer than the others; the produced inner portion of the basal joints, which scarcely reach to the end of the outer secondary ones, have the sides slightly rounded and taper to the narrowly-rounded apex; they are each furnished with five setæ—three on the lower inner margin and two close together at the apex, as shown by the following drawing (fig. 7).

The furcal joints are shorter than the last abdominal segment; they each appear to be abruptly truncate, and their principal setæ are elongated and slender (fig. 8).

Habitat.—In a shore gathering collected at Musselburgh, Firth of Forth, in 1894; rather rare.

Remarks.—The copepod described above has as great resemblance to *Stenhelia* as to *Dactylopus* in its general appearance and in some of its structural details, as, for example, in the structure of the first thoracic feet, but in the structure of the antennules, mandibles, and fifth thoracic feet its relationship appears to be closer to *Dactylopus*; it differs from described species in structure of the antennules, in the comparatively stout form of the first thoracic feet, and in the form and armature of the fifth pair. It appears to be a littoral species, as I have only observed it in inshore gatherings.

Dactylopus vararensis, T. Scott, sp. nov. Pl. iii., figs. 17–24.

Description of the Female.—Body moderately stout, length about ·75 mm. (about $_3{}^1{}_3$ of an inch).

Rostrum prominent, slightly incurved (fig. 17).

Antennules short, eight-jointed, the first four and last joints sub-equal in length, the other three short; the first four joints are also considerably stouter than the last four (fig. 18); the formula shows approximately the proportional lengths of the joints:—

23	22	29	18	6	10	7	20
1	2	3	4	5	6	7	8

The secondary branches of the antennæ are composed of three joints, but the middle one is small.

The mandibles are stout and sub-cylindrical, and the biting part is somewhat oblique and armed with about three strong and several small spiniform teeth; the basal joint of the palp is somewhat dilated, and carries two branches, the proximal one being considerably smaller than the other, as shown in the drawing (fig. 19).

The second maxillipeds have the penultimate joint moderately elongated and narrow, with a fringe of small setæ on the inner aspect of its proximal half; the end joint is scarcely broader than the base of the terminal claw, which is moderately long and slender, and incurved toward the extremity (fig. 20).

In the first pair of thoracic feet, the outer branches, which are composed of three sub-equal joints, are rather longer than the first joint of the inner branches; the first two joints are armed with moderately strong spines on the outer distal angles, while the end joint bears, at the apex, two slender spines and two setæ; the first joint of the outer branches is moderately stout, but scarcely twice as long as the combined lengths of the outer two, which are small, narrow, and sub-equal: the inner branches are armed with a stout terminal claw and two setæ; the first and second joints are also each provided with a seta near the distal end of the inner

margin (fig. 21). The second, third, and fourth pair are somewhat similar to those of the species previously described (fig. 22 represents the fourth pair).

The fifth pair are small and foliaceous, the produced inner portion of the basal joint reaches to about the end of the secondary joints and bears five setæ on its broadly rounded end; the two outermost setæ are, like the next two, situated near to each other, but there is a comparatively wide space between each pair, the innermost seta is smaller and spiniform; the outer secondary joints are broadly ovate, being only a little longer than broad, and are each provided with five spines, the middle one of which appears to be more slender than the others, as shown by the drawing (fig. 23).

The furcal joints are very small, being almost rudimentary, while the principal tail setæ are short and stout (fig. 24).

Habitat.—Moray Firth, Station IV., collected 1898; apparently rare.

Remarks.—This species is readily distinguished by the peculiar structure of the first thoracic feet, and the comparatively small fifth feet of the female; the fifth pair is not unlike the fifth pair of *Dactylopus minutus*, Claus, but the first pair is very different. *Dactylopus vararensis* was obtained in a gathering of small Crustacea collected in the Moray Firth in 1878, but as the form could not be recognised at the time it was put aside for further study, and I am still unable to identify it with any described species.

Dactylopus mixtus, T. Scott, sp. nov. Pl. iii., figs. 9–16.

Description of the Female.—This form has a general resemblance to both *D. tenuiremis*, G. S. Brady, and *D. longirostris*, Claus. The body is moderately robust, and in specimens preserved in spirit the abdomen is considerably reflexed; there is a prominent rostrum, but the furcal joints are very short (fig. 9). Length ·6 mm. (about $\frac{1}{42}$ of an inch).

The antennules (fig. 10) are moderately elongated and composed of eight joints; the second joint is the largest, the fourth and last are also comparatively long, being about half as long again as the one immediately preceding; the third, fifth, sixth, and seventh joints are small. The antennules are thus somewhat like those of *D. longirostris*, Claus, in structure, as shown by the drawing.

The antennæ are provided with three-jointed secondary branches similar to those of *D. strömii*, Baird.

The mandibles are well developed, the biting edge is armed with several spine-like teeth, the two outer ones are stout, but the others are slender; the basal joint of the mandible palp moderately dilated, and bears two small branches towards its distal end; the inner branch is somewhat smaller than the other and is apparently two-jointed; the other branch consists of a single joint (fig. 11).

First maxillipeds somewhat similar to those of *D. strömii*.

The second maxillipeds are of moderate size (fig. 12); the terminal claw springs from a narrow joint about half as long as itself; the second joint is furnished with several small spine-like setæ on the inner margin, and the first joint also carries one or two small hairs at its distal end

The inner branches of the first thoracic feet are elongated, the first joint being longer than the entire outer branches; the second joint is very small, but the second and third together are about equal to half the length of the first joint; the first joint is fringed interiorly with minute slender hairs, while a moderately long seta springs from its inner distal angle, the proximal part of the outer margin is provided with a number

of minute spines; the second joint bears a feathered seta interiorly, and a few small hairs on the exterior edge; while the end joint, besides being furnished with a few minute spines on the outer margin, bears also a short but moderately stout terminal claw and two slender hairs—the one very short and the other about twice the length of the claw. The outer branches, which are shorter than the first joint of the inner ones, are composed of three sub-equal joints, the first and second are each armed with a strong dagger-like spine on the outer distal angle, and the second bears also a moderately long seta on its inner distal angle; the end joint is furnished with four spines on the outer margin and apex, but two of the marginal spines are comparatively small, a slender and slightly bent seta also springs from the inner apical angle, as shown in the drawing (fig. 13).

The second, third, and fourth pairs have both branches three-jointed, the inner being shorter than the elongated outer branches. The structure and armature of the second and third pairs are not unlike those of the same appendages in *D. strömii*. In the fourth pair the inner branches scarcely reach beyond the end of the second joints of the outer branches, the first and second joints are each provided with one seta near the distal end of the inner margin, while the third joint bears two marginal and two apical setæ; a small slender spine also springs from near the end of the outer margin. In the second and third pairs of feet the second joint of the inner branches is furnished with *two* setæ on its inner aspect, while the end joint of the second pair carries one marginal and two terminal setæ, and a small and slender terminal spine; but the same joint of the third pair has five marginal and apical setæ in addition to the small apical spine. The outer branches of the fourth pair do not differ much in structure and armature from the outer branches of the second and third pairs; the first and second joints are each provided with a spine on the outer and a plumose seta on the inner distal angles; the third joint bears two small spines on the outer margin and another on the outer angle of the apex, besides setæ on the inner margin and apex, as shown by the drawing (fig. 14).

The fifth pair, which are lamelliform, have the inner produced portion of the basal joint broadly sub-cylindrical, with the apex obliquely truncate and armed with five setæ, the two inner setæ are stout and spiniform, but the other three are more slender; the two outer setæ are close together, but the others are more widely separated; the secondary joint is also broadly sub-cylindrical, scarcely one and a half times longer than broad and obliquely truncate at the end; the three outermost are sub-equal, moderately short and stout; the next two are slender, one being more elongated than the others, while the innermost seta springs from a sub-marginal notch, as shown by the drawing (fig. 15).

The furcal joints are very short, and the principal tail setæ are somewhat dilated at the base. This species carries two ovisacs, as shown in the drawing (fig. 16).

Habitat.—Granton, Firth of Forth (1894). Fishery Board's Hatchery at Bay of Nigg, Aberdeen, November 23rd, 1900.

Remarks.—I was at first inclined to ascribe this form to Claus's *Dactylopus longirostris*, but it differs rather markedly in the structure of the fifth feet of the female. *Dactylopus tenuiremis*, G. S. Brady, also resembles the form just described in its elongated antennules and in one or two other minor details, but it distinctly differs in the proportional lengths of the joints of the outer branches of the first feet and in form of the fifth pair; and I do not know of any other species with which it can be identified.

Dactylopus coronatus, T. Scott.

1894. *Dactylopus coronatus*, T. Scott. Twelfth Ann. Report Fishery Board for Scotland, pt. iii., p. 255, pl. ix., figs. 12–20.

This *Dactylopus* was obtained very sparingly in material dredged in shallow water off Musselburgh; it has been already taken near the Bass Rock and in Largo Bay, but is nowhere very common.

Dactylopus brevicornis, Claus.

1866. *Dactylopus brevicornis*, Claus. Die Copepoden fauna von Nizza, p. 29, t. iii., figs. 20–25.

1880. *Dactylopus brevicornis*, Brady. Brit. Copep., vol. ii., p. 118, pl. lvii., figs. 10–12; lviii., fig. 14.

Several specimens of this small species were obtained in the old quarry near Granton, Firth of Forth. It appears to be a littoral form, but is found also in moderately deep water, and has been recorded from several places round the Scottish coasts, but usually very sparingly. Among other *Dactylopus* from the same gathering was the well-marked *D. flavus*, Claus, and one or two other common forms.

Dactylopus debilis, Giesb. Pl. v., figs. 20–31.

1882. *Dactylopus debilis*, Giesb. Freileb. Copep. d. Kieler Fohrde, p. 122, pl. i., figs. 7, 19 *et. seq.*

Description of the Female.—Body slender, and, in spirit specimens, strongly reflexed (fig. 20). The length of the specimen represented by the drawing is only slightly over half a millimetre (about $\frac{1}{46}$ of an inch). The rostrum is moderately prominent, but the furcal joints are very short (fig. 31).

The antennules are of moderate length and composed of eight joints, the first four large but the others considerably smaller (fig. 21). The proportional lengths of the various joints are shown approximately by the annexed formula:—

Proportional lengths of the joints,	18 · 17 · 13 · 18 · 6 · 8 · 6 · 11
The numbers of the joints, -	1 · 2 · 3 · 4 · 5 · 6 · 7 · 8

Antennæ short, moderately stout, two-jointed, and furnished with a three-jointed secondary branch (fig. 22).

Mandibles small, the biting edge armed with a number of small teeth; the basal joint of the palp is dilated and bears two small branches as shown in the drawing (fig. 23).

The second maxillipeds are moderately slender, so also is the elongated terminal claw with which they are armed (fig. 24).

The first pair of thoracic feet are somewhat similar to those of *Dactylopus minutus*, Claus; the first joint of the inner branches is long and slender, being about three times longer than the combined lengths of the second and third joints, and it is furnished with a small seta near the distal end of the inner margin; the terminal claw of the inner branches is moderately stout, and there are also two terminal setæ. The outer branches, which are also slender, are rather shorter than the first joint of the inner ones (fig. 25).

The next three pairs are also slender and resemble each other, except in the following particulars:—In the second pair the inner branches are slightly longer than the outer, and while the last joint of the inner branches is provided with a seta on the inner margin, the end joint of the outer branches has no seta similarly situated. In the third pair the inner

and outer branches are about equal in length, and in this pair, while the first and second joints of the inner branches are each provided with a single seta on their inner margin, the third joint bears two setæ. On the other hand, the inner margins of only the second and third joints are each provided with one seta (fig. 26). In the fourth pair the inner branches are rather shorter than the outer, and the armature of the inner margins of both branches resembles that of the third pair except that the last joint of the inner branches is furnished with one instead of two setæ on its inner edge (fig. 27).

The fifth pair are moderately large and foliaceous ; the inner produced portion of the basal joint is generally of a sub-cylindrical form, but the distal end tapers to a blunt-pointed apex from which spring two setæ of moderate but unequal length ; the distal half of the inner margin carries also two moderately stout spines, as well as an elongated seta, as shown in the drawing (fig. 29). The secondary joint has a sub-ovate outline, and its extremity extends somewhat beyond the end of the inner produced portion of the basal joint ; it is nearly twice as long as broad and is furnished with five setæ which are arranged round the distal end of the joint as shown by fig. 9 already referred to.

The male somewhat resembles the female, but there are the following important differences in addition to the usual modification in the antennules :—(1) The inner branches of the second pair of thoracic feet are distinctly modified ; these branches in the male appear to be only two-jointed, the first joint is moderately stout but short, the second extends into a prolonged and stout tapering process which reaches considerably beyond the ends of the outer branches ; the first joint also bears one seta on its inner edge, but the elongated second joint is furnished with two (fig. 28).

The fifth feet in the male are small ; the inner portion of the basal joint is broadly cone-shaped and carries two apical setæ ; the secondary joint is moderately broad and of a somewhat ovate form, and is provided with five setæ, the two setæ on the outer margin are short and spiniform, the apical seta is elongated and slender, while the two on the inner edge are moderately stout and appear to be plumose (fig. 30). There is also a small trispinous appendage on the first segment of the abdomen.

Habitat.—Off Musselburgh, Firth of Forth ; not common.

Remarks.—This small species seems to agree better with *Dactylopus minutus*, Claus, than with any other member of the genus, but it differs distinctly from that species by the structure of the antennules and of the fifth pair of feet in the female, and by the peculiar character of the second pair of feet in the male.

Genus *Thalestris*, Claus (1863).

Several species belonging to the genus *Thalestris* have been observed in gatherings recently examined, and the following are now recorded for the first time from the Firth of Forth.

Thalestris peltata, Boeck.

1864. *Anemophia peltata*, Boeck. Oversigt Norges Copepoder, p. 45.
1880. *Thalestris peltata*, Brady, Brit. Copep., vol. ii., p. 138, pl. liii., figs. 11–19.
1895. *Thalestris peltata*, T. and A. Scott, Ann. Nat. Hist. (6), vol. xiv., p. 351, pl. xv., figs. 11–15.; pl. xvi., figs. 1–8.

The somewhat aberrant species of *Thalestris* was obtained off Musselburgh in shallow water (3–4 fathoms). *Thalestris peltata* appears to be a

moderately rare species, but it has so much the appearance of a *Scutellidium* or a *Zaus* that it may have been frequently overlooked. *Thalestris rufocincta*, Norm., and *Thalestris clausii*, Norm., were taken in the same gathering with *T. peltata*.

Genus *Westwoodia*, Dana (1855).

Westwoodia nobilis, Baird.

1845. *Arpacticus nobilis*, Baird, Trans. Barw. Nat. Club, vol. ii., p. 155.
1880. *Westwoodia nobilis*, Brady, British Copepoda, vol. ii., p. 141, pl. lxiii., figs. 1–13.

This prettily-coloured Harpactid was observed in the same gathering with the *Thalestris* just mentioned. It seems to be a littoral form, and its habitat here agrees with what is stated by Prof. G. S. Brady and Rev. A. M. Norman, but it has also been obtained in water of moderate depth, as off Portincross, Firth of Clyde, where it occurred at depths ranging from ten to thirty fathoms.*

LICHOMOLGIDÆ.

Genus *Paranthessius*, T. Scott, gen. nov.

Antennules short and seven-jointed. Antennæ four-jointed, armed with a stout terminal claw. Mandibles and maxillæ somewhat like those of *Lichomolgus fucicolus*. Anterior maxillipeds small, furnished with strongly curved and elongated terminal claws. The first three pairs of thoracic feet are similar to those of *Lichomolgus*, but in the fourth pair the inner branches appear to be entirely wanting. Fifth pair rudimentary or very small.

Paranthessius dubius, T. Scott, sp. nov. Pl. vi., figs. 16–24.

A single male specimen of a somewhat curious Lichomolgus-like copepod was obtained in some dredged material sent from the Clyde, and collected on June 13, 1899. It has been left unrecorded hitherto in expectation that other specimens, especially females, might be found, and a more exact knowledge obtained of its structure and affinities. It differs in several particulars from any described genus or species at present known to me, and I therefore submit the following description of it under the name of *Paranthessius dubius*.

The male in its general outline somewhat resembles *Pseudopsyllus elongatus*, a copepod described in my paper in Part III. of the Twentieth Annual Report. The body is elongated and narrow; the cephalo-thorax is composed of five segments, the first is rather broader than the others and is considerably longer than the combined lengths of the remaining four segments; these four segments, which are sub-equal in length, become gradually narrower, so that the last is narrower than the first segment of the abdomen. The first abdominal segment is considerably dilated, but the remaining segments are short and narrow; the furcal plates, which are moderately broad, are about as long as the last two segments of the abdomen (fig. 16). The length of the specimen is fully 2 mm. (about $\frac{1}{12}$ of an inch).

The antennules (fig. 17) are short and moderately stout and composed of seven joints, the second joint is the largest, the third and fourth are

* British Copepoda, vol. ii., p. 142 (1880).

very small, but the remaining three are about equal in length and taper slightly to the distal end. The antennules are also sparingly setiferous, and carry several stout and elongated sensory filaments.

The antennæ are composed of four joints, the first two are large and somewhat dilated, but the third and fourth are narrow—the third being also very short; the end joint is furnished at the apex with a stout, strongly-hooked claw and several spiniform setæ (fig. 18).

The mandibles and maxillæ resemble very closely the same appendages in *Lichomolgus fucicolus*, G. S. Brady. The mandible is small, with a dilated base, and carries two stout, moderately long, and strongly curved apical appendages and two small basal setæ. The maxillæ are small and digitiform, and at the apex furnished with two slender spiniform setæ (fig. 19).

Second maxillipeds very small, and each armed with a stout, strongly-curved, and moderately elongate terminal claw (fig. 20).

The first feet were damaged, and the inner branches are not figured. The outer branches are three-jointed; the first joint is short and bears a sabre-like spine on the outer distal angle, but no setæ on the inner margin. The second joint, which is also short, carries a sabre-like spine on the outer distal angle and a moderately long seta on the inner margin. The third joint, which is longer and narrower than those preceding, is furnished with three short sabre-like spines on the outer margin, and a similar but rather longer one at the apex. There are also four moderately long plumose setæ on the inner margin (fig. 21).

The second pair have the outer branches very similar to those of the first pair in structure and armature, except that the third joints have five setæ on the inner edge. The first and second joints of the inner branches have no spines or setæ on the outer margins, but the third joint is provided with a short spine near the distal end of the outer edge, and with two that are longer but of about equal length at the apex. The first joint has one seta on the inner margin, the second two, and the third three. The end joint is also considerably longer than the first or second (fig. 22).

In the third pair, the first and second joints of the outer branches are similar in structure and armature to the same joints in the second pair; the third joints are armed with two sabre-like spines on the outer margin, and with two similar terminal spines; there is also a row of five plumose setæ on the inner margin. The inner branches are provided with one seta on the inner edge of the first joint, and two on the inner edge of the second and third joints. The third joint bears also three moderately long sabre-like spines on its truncate apex, but there are no spines or setæ on the inner margins (fig. 23).

In the fourth pair, the inner branches seem to be entirely obsolete, for on either foot there is no appearance of the endopodites having been broken off.

The outer branches are normal and their armature is very similar to that of the outer branches of the third pair (fig. 24).

The fifth pair are rudimentary, and consist each of a minute digitiform process bearing two small hairs, as shown in fig. 16.

No form that could be regarded as the female of this species has yet been observed.

DESCRIPTION OF THE PLATES.

PLATE II.

Stephos scotti, G. O. Sars.

		Diam.
Fig. 1.	Female, side view	× 70.
Fig. 2.	Male, side view	× 70.
Fig. 3.	Fifth pair of feet, female	× 360.
Fig. 4.	Fifth pair of feet, male	× 158.

Parastephos pallidus, G. O. Sars.

Fig. 5.	Female, side view	× 39½.
Fig. 6.	Male, side view	× 39½.
Fig. 7.	Antennule, female	× 70.
Fig. 8.	Foot of second pair	× 79.
Fig. 9.	Fifth pair of feet, female	× 106.
Fig. 10.	Fifth pair of feet, male	× 79.

Pseudophænna typica, G. O. Sars.

Fig. 11.	Male, side view	× 35.
Fig. 12.	Male, dorsal view	× 35.
Fig. 13.	Antennule, male	× 70.
Fig. 14.	Fifth pair of feet	× 154.
Fig. 15.	Extremity of left foot, greatly magnified.	

Enhydrosoma gracile, T. Scott, sp. nov.

Fig. 16.	Female, side view	× 158.
Fig. 17.	Antennule	× 360.
Fig. 18.	Antenna	× 360.
Fig. 19.	Mandible and palp	× 540.
Fig. 20.	Second maxilliped	× 540.
Fig. 21.	Foot of first pair	× 540.
Fig. 22.	Foot of second pair	× 540.
Fig. 23.	Foot of fourth pair	× 540.
Fig. 24.	Foot of fifth pair, female	× 720.
Fig. 25.	Foot of fifth pair, male.	× 720.
Fig. 26.	Furcal joints and last two segments of abdomen	× 270.

PLATE III.

Enhydrosoma gracile, T. Scott, sp. nov.

Fig. 1.	Antennule, male	× 360.

Dactylopus littoralis, T. Scott, sp. nov.

Fig. 2.	Female, side view	× 70.
Fig. 3.	Antennule	× 360.
Fig. 4.	Second maxilliped	× 720.
Fig. 5.	Foot of first pair	× 360.
Fig. 6.	Foot of fourth pair	× 360.
Fig. 7.	Foot of fifth pair	× 540.
Fig. 8.	Furcal joints and last two segments of abdomen	× 240.

Dactylopus mixtus, T. Scott, sp. nov. Diam.

Fig. 9. Female, side view . . . . . × 52.
Fig. 10. Antennule . . . . . × 270.
Fig. 11. Mandible and palp . . . . . × 360.
Fig. 12. Second maxilliped . . . . . × 180.
Fig. 13. Foot of first pair. . . . . × 240.
Fig. 14. Foot of fourth pair . . . . . × 180.
Fig. 15. Foot of fifth pair . . . . . × 270.
Fig. 16. Furcal joints and last two segments of abdomen . . × 133.

Dactylopus vararensis, T. Scott, sp. nov.

Fig. 17. Female, side view . . . . . × 79.
Fig. 18. Antennule . . . . . × 540.
Fig. 19. Mandible and palp . . . . . × 720.
Fig. 20. Second maxilliped . . . . . × 720.
Fig. 21. Foot of first pair . . . . . × 360.
Fig. 22. Foot of fourth pair . . . . . × 270.
Fig. 23. Foot of fifth pair . . . . . × 270.
Fig. 24. Furcal joints and last two segments of abdomen . . × 105.

Enhydrosoma minutum, T. Scott, sp. nov.

Fig. 25. Foot of second pair, female . . . . . × 540.

PLATE IV.

Ectinosoma curticorne, Boeck.

Fig. 1. Furcal joints and last two segments of abdomen . . × 270.

Dactylopus mixtus, T. Scott, sp. nov.

Fig. 2. Antenna . . . . . × 270.

Delavalia minutissima, T. Scott, sp. nov.

Fig. 3. Female, lateral view . . . . . × 158.
Fig. 4. Antennule . . . . . × 540.
Fig. 5. Foot of first pair . . . . × 720.
Fig. 6. Foot of second pair . . . . . × 540.
Fig. 7. Foot of third pair . . . . × 540.
Fig. 8. Foot of fourth pair . . . . . × 540.
Fig. 9. Foot of fifth pair . . . . . × 540.
Fig. 10. Furcal joints and last two segments of abdomen . . × 270.

Tetragoniceps pygmæus, T. Scott, sp. nov.

Fig. 11. Female, lateral view . . . . . × 150.
Fig. 12. Antennule . . . . . × 270.
Fig. 13. Antennule, male . . . . . × 160.
Fig. 14. Foot of first pair . . . . . × 540.
Fig. 15. Foot of third pair, male . . . . . × 540.
Fig. 16. Foot of fifth pair, female . . . . × 540.
Fig. 17. Foot of fifth pair, male . . . . × 540.
Fig. 18. Appendage to first abdominal segment . . × 540.
Fig. 19. Furcal joints and last two segments of abdomen . . × 270.

Cletodes neglecta, T. Scott, sp. nov. Diam.

Fig. 20. Female, dorsal view . . . . . × 79.
Fig. 21. Antennule . . . . . × 360.
Fig. 22. Antennule, male . . . . . × 270.
Fig. 23. Antenna . . . . . × 540.
Fig. 24. Mandible and palp . . . . . × 540.
Fig. 25. Second maxilliped . . . . . × 720.
Fig. 26. Foot of first pair . . . . . × 160.
Fig. 27. Foot of second pair . . . . . × 160.
Fig. 28. Foot of third pair . . . . . × 270.
Fig. 29. Foot of fourth pair . . . . . × 270.
Fig. 30. Foot of fifth pair, female . . . . . × 216.
Fig. 31. Foot of fifth pair, male . . . . . × 540.

PLATE V.

Ameira pusilla, T. Scott, sp. nov.

Fig. 1. Female, lateral view . . . . . × 158.
Fig. 2. Antennule . . . . . × 540.
Fig. 3. Antenna . . . . . × 720.
Fig. 4. Mandible and palp . . . . . × 1080.
Fig. 5. Second maxilliped . . . . . × 1080.
Fig. 6. Foot of first pair . . . . . × 720.
Fig. 7. Foot of second pair . . . . . × 540.
Fig. 8. Foot of fourth pair . . . . . × 360.
Fig. 9. Foot of fifth pair . . . . . × 1080.
Fig. 10. Furcal joints . . . . . × 270.

Ameira ambigua, T. Scott, sp. nov.

Fig. 11. Female, lateral view . . . . . × 106.
Fig. 12. Antennule . . . . . × 270.
Fig. 13. Antenna . . . . . × 360.
Fig. 14. Mandible and palp . . . . . × 540.
Fig. 15. Second maxilliped . . . . . × 540.
Fig. 16. Foot of first pair . . . . . × 270.
Fig. 17. Foot of second pair . . . . . × 270.
Fig. 18. Foot of fourth pair . . . . . × 270.
Fig. 19. Foot of fifth pair . . . . . × 360.

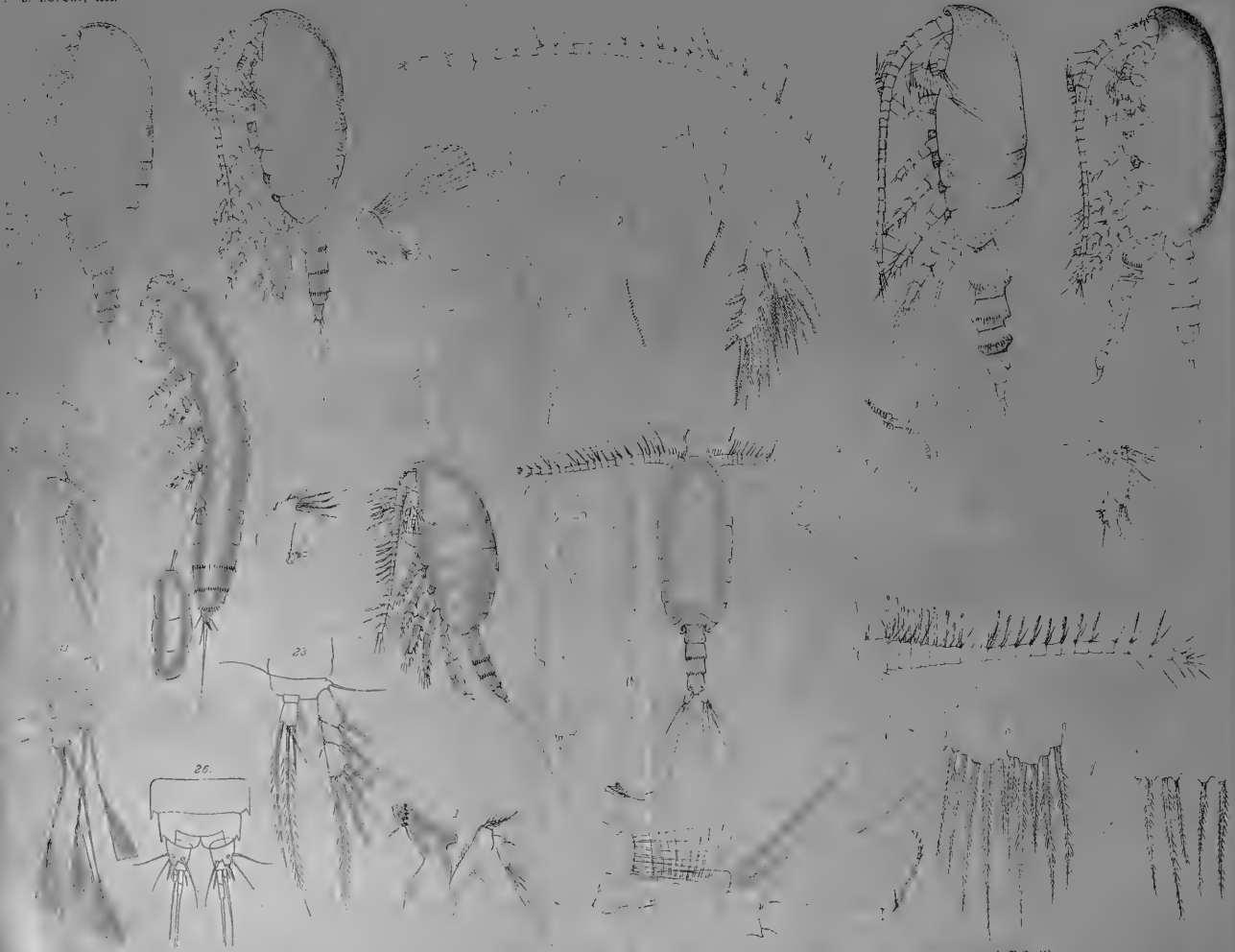
Dactylopus debilis, Giesbrecht.

Fig. 20. Female, lateral view . . . . . × 106.
Fig. 21. Antennule . . . . . × 540.
Fig. 22. Antenna . . . . . × 540.
Fig. 23. Mandible and palp . . . . . × 720.
Fig. 24. Second maxilliped . . . . . × 720.
Fig. 25. Foot of first pair . . . . . × 540.
Fig. 26. Foot of third pair . . . . . × 540.
Fig. 27. Foot of fourth pair . . . . . × 540.
Fig. 28. Foot of second pair, male . . . . . × 540.
Fig. 29. Foot of fifth pair, female . . . . . × 720.
Fig. 30. Foot of fifth pair, male . . . . . × 1080.
Fig. 31. Furcal joints . . . . . greatly enlarged.

PLATE VI.

Enhydrosoma minutum, T. Scott, sp nov.

Fig. 1. Female, lateral view . . . . . × 159.
Fig. 2. Antennule . . . . . × 540.
Fig. 3. Second maxilliped . . . . . × 720.
Fig. 4. Foot of fourth pair . . . . . greatly magnified.
Fig. 5. Foot of fifth pair . . . . . × 760.



A. Scott, *del. ad nat.*

FIGS. 1-4.—*Stephos scotti* (G. O. Sars). FIGS. 5-10.—*Parastephos pallidus* (G. O. Sars). FIGS. 11-15.—*Pseudophonna typica* (G. O. Sars). FIGS. 16-26.—*Enhydrosoma gracile* (T. Scott).

A. Scott, *del. ad nat.*

FIG. 1.—*Enhydrosoma gracile* (T. Scott). FIGS. 2-8.—*Dactylopus littoralis* (T. Scott). FIGS. 9-16.—*Dactylopus mixtus* (T. Scott). FIGS. 17-24.—*Dactylopus variegatus* (T. Scott).
FIG. 25.—*Enhydrosoma minutum* (T. Scott).

FIG. 1.—*Ixodes canisuga* (Boeck). FIG. 2. *Dactylopsylla* [illegible] (T. Scott). FIGS. 3-10. *Dolichodina mantidarum* (T. Scott). FIGS. 11-19. *Tetragonaspis pygmæa* (T. Scott).
FIGS. 20-21.—*Cleiodes saglena* (T. Scott).

A. Scott, *del. ad nat.*

Figs 1-10.—*Ameira pusilla* (T. Scott). Figs. 11-19.—*Ameira ambigua* (T. Scott). Figs. 20-31.—*Dactylopus parvus* (T. Scott).

A. Scott, *del. ad nat.*

FIGS. 1-5.—*Enhydrosoma minutum* (T. Scott). FIGS. 6-12.—*Laophonte gracilis* (T. Scott). FIGS. 13-15.—*Pseudocyclops obtusatus* (Brady and Robertson). FIGS. 16-24.—*Paranthessius dubius* (T. Scott).

Laophonte gracilis, T. Scott, sp. nov.

Diam.

Fig. 6. Female, lateral view . . . . . × 79.
Fig. 7. Antennule . . . . . × 360.
Fig. 8. Second maxilliped . . . . . × 540.
Fig. 9. Foot of first pair . . . . . × 360.
Fig. 10. Foot of fourth pair . . . . . × 270.
Fig. 11. Foot of fifth pair . . . . . × 760.
Fig. 12. Caudal joints with last two segments of abdomen . . × 240.

Pseudocyclops obtusatus, Brady and Robertson.

Fig. 13. Female, lateral view . . . . . × 79.
Fig. 14. Antennule and rostrum . . . . . × 180.
Fig. 15. Foot of fifth pair . . . . . × 270.

Paranthessius dubius, T. Scott, sp. nov.

Fig. 16. Male, dorsal view . . . . . × 35.
Fig. 17. Antennule . . . . . × 53.
Fig. 18. Antenna . . . . . × 79.
Fig. 19. Mandible and maxilla . (*m*—maxilla) . . . × 540.
Fig. 20. Second maxilliped . . . . . × 158.
Fig. 21. Foot of first pair, outer branch . . . . × 158.
Fig. 22. Foot of second pair, inner branch . . . . × 106.
Fig. 23. Foot of third pair . . . . . × 106.
Fig. 24. Foot of fourth pair . . . . . × 106.

III.—ON THE LARVAL AND EARLY YOUNG STAGES, AND RATE OF GROWTH, OF THE SHORE-CRAB (*CARCINUS MÆNAS*), Leach. By H. Chas. Williamson, M.A., D.Sc., Marine Laboratory, Bay of Nigg, Aberdeen. (Plates vii.–xiii.)

CONTENTS.

INTRODUCTION.

A considerable amount of attention has at various times been devoted to the larval stages of *Carcinus mœnas*. This crab is one of the commonest on the British coasts, and its Zoëa may be easily captured near the shore by the tow-net during the spring and summer.

J. Vaughan Thompson first demonstrated the fact that the Zoëa and Megalops were developmental stages in the life-history of the decapod Crustacea. In 1828 he described* the larva of *Cancer pagurus*, the eggs of which had hatched under his observation. The larva proved to be a Zoëa, "which presented exactly the appearance of *Zoëa taurus*, with the addition of lateral spines to the corselet." Later, in 1835, in the paper† in which he showed that the Megalops is also simply a young stage of a crab, he described a Zoëa as that of *Carcinus mœnas* which clearly does not belong to this species. The Zoëa of the latter has no lateral spines on the carapace, whereas that figured by Thompson has a very prominent lateral spine. This mistake was followed by Claus.‡

* J. Vaughan Thompson, "Zoological Researches," vol. i., Pt. I., Cork, 1828. [According to Cano, Cavolini was the first to recognise the Zoëa. He described and figured the larva of *Pachygrapsus marmoratus* ("Morfologia dell'aparecchio sessuale feminile ecc. nei Crostacei Decapodi"—*Mittheil. a. d. Zool. Stat. Neapel*, ix. Bd., 4 Heft, 1890, p. 505.]

† J. Vaughan Thompson, "The Double Metamorphosis in Decapod Crustacea," *Phil. Trans. Roy. Soc., London*, 1835, p. 359, 1 pl.

‡ Claus, "Zur Kenntniss der Malacostrakenlarven," *Wurzburger Naturw. Zeitschr*; 1861.

Thompson gave drawings of what he labelled the Megalops and first young form of *Carcinus*. He believed that they were derived from the Zoëa just mentioned. The Megalops and first young stage do belong to *Carcinus mœnas*, but they were not derived from the Zoëa in question.

R. Q. Couch in 1843 described* the Zoëa of *Carcinus*, which he obtained by keeping the berried female in captivity until the eggs were hatched. He gave drawings of the Zoëa, Megalops, and first young stage of this form; the sketches of the two former are not diagnostic. Both Thompson and Couch regarded the Zoëa stages as one stage, and the Megalops as the second stage. While they recognised that the Zoëa grew larger, and that certain organs developed during the Zoëa period, they did not state distinctly that these changes in size, etc., are brought about by moults, not merely by gradual growth. Thompson also discriminated between young and full-grown Megalopa.

Du Cane† had in 1839 given a description with drawings of the Protozoëa and first Zoëa.

The first exhaustive treatment of the Zoëa and Megalops stages was made by Spence Bate‡ in 1859. In tracing the development of the Zoëa he drew attention to the fact that the changes from a Zoëa to the crab are gradual and not really of the nature of a metamorphosis. He said in this connection (*p. 590*)—"In the highest types of Crustacea, the immense variety of change from the *Zoëa* to the complete animal is but the result of *subordinate* becoming *more important* parts, together with the development of others not yet present, and therefore hardly acceptable under the signification of metamorphosis." "The author is perfectly aware that in Insecta the change of the animal within the chrysalis is gradual in development; but he wishes to show that there is no stage in Crustacea answering to the chrysalis; that the moults in process of development of the Crustacea are of the same kind as those which take place in the adult condition."

Spence Bate gave drawings of the appendages, and traces their development through a number of stages. They are, however, made on a small scale, and are to a considerable extent vitiated by the fact that stages belonging to species other than *Carcinus* have been introduced into the series. He depicted three Zoëa stages, of which the last does not belong to *Carcinus*. He did not satisfy himself as to the number of moults which take place in the Zoëa period, and he was of the opinion that the Megalops stage was a period of stages analogous to that of the Zoëa period. He had arranged two Megalopa and a young form into a series. The first of these is not a *Carcinus*, the second and the third could not from the drawings be recognised as belonging to this species. There is only one Megalops stage.

Brooke described the Megalops and six successive stages of *Carcinus*. He, following Spence Bate, regarded the Megalopa which he had collected as belonging to the *last* Megalops stage. His drawing of the Megalops does not show the characteristic long curved bristles which are present on the dactylopodite of the fifth pereiopod of this stage.

The Hatching Period: the Occurrence of the Zoëa.

No investigation was made with the view of finding out during how many months the Zoëæ of *Carcinus* were to be found in the sea, but

* R. Q. Couch, "On the Metamorphosis of the Decapod Crustaceans," *Eleventh Annual Report of the Royal Cornwall Polytechnic Society, Falmouth*, 1843; 1 pl.

† Du Cane, "On the Metamorphosis of the Crustacea," *Annals of Natural History*, vol. iii., 1839; 1 pl.

‡ Spence Bate, "On the Development of Decapod Crustacea," *Phil. Trans. Roy. Soc., London*, 1859, p. 589, pl. xl.-xlvi.

collateral evidence furnished by the examination of berried females indicates that hatching takes place over a considerable portion of the year.

The eggs hatched in the Laboratory on two occasions, viz. in May and July.

Several females spawned in the Laboratory at the end of September and in October.

The Egg. When first extruded, the eggs are in the mass of a light orange colour; the single egg is straw-coloured. The eggs are nearly circular; some are oval. Four eggs measured as follows, ·375 : ·37 : ·37 : ·35 × ·4 mm.

As development proceeds, the colour of the egg changes to a deep amber.

When the eggs are ready to hatch the amber colour has disappeared, and the mass is of a dirty grey colour. The change from the amber to the grey takes place not very long before hatching, probably within a month.

The length of the period of incubation is not known. Meek suggests four months. This is very probably not an over-estimate.

Berried females may be got on the beach between tidemarks during nearly the whole year. The eggs on different females are in different stages of development, which indicates a more or less extended spawning season.

In January at Dunbar the eggs of a female were of a dark amber colour, and the eyes were present in the embryo.

In April twenty-three females were examined at Dunbar. On the majority of these the eggs were of a dirty grey colour (ready to hatch) in five or six the eggs were of a light orange tinge.

In May a considerable number have been examined at Dunbar and at the Bay of Nigg. One measuring 6 cm. across had eggs ready to hatch, and another 4 cm. had advanced eggs; seven had eggs of a light amber colour, and one of these measured just under 4 cm. in breadth. Of several crabs sent from the Dornoch Firth, two had orange eggs, while in the case of the others, hatching was proceeding. In a lot examined at the Bay of Nigg during this month the smaller females had advanced eggs, the larger had orange-coloured eggs.

In June at Dunbar one of those found had eggs ready to hatch, half-a-dozen others had orange eggs.

In July the eggs hatched in the Laboratory.

In September, a female 6 cm. was found carrying advanced eg the eyes were formed.

Females have been found with empty egg capsules attached in con siderable quantity to the swimmerets in May, June, and August These crabs had hatched their eggs shortly before capture.

These facts then indicate that the hatching of *Carcinus* occurs over a long period, viz. from April to end of July. Du Cane found that the eggs hatched in March. In putting the period during which the Zoëa of this crab may be found as from March to end of July, I do not think an over-estimate is made.

The fact moreover that crabs having eggs ready to hatch, while others carry eggs which will not hatch for some time, are got simultaneously points to an extended spawning season.

The spawning season of *Cancer pagurus* lasts three months, viz. November, December, and January. Hatching of this form took place at Dunbar in July and August, and at Bay of Nigg, August and September (end of). In 1902, while the eggs of certain of these crabs were hatching, the eggs of other individuals were still red.

The Larval Stages.

The Larval stages of this form are divisible into three groups: (1) the Protozoëa stage: (2) the Zoëa stages, four in number: (3) the Megalops stage.

Protozoëa (Fig. 160).

The so-called Protozoëa stage was described by Du Cane, Spence Bate, and other authors. It is of very short duration. The larva leaves the egg capsule in the condition shown in the figure. It has neither the rostral nor dorsal spine. It immediately casts its delicate integument and appears as a Zoëa of the I. stage.

I have not noticed the Protozoëa stage in cases where the larvæ have hatched out in a tank. It may however be got by washing the egg-mass of a female during the time the young are hatching.

Faxon* gives a correct description of this stage, and it is not necessary here to recapitulate it.

The Zoëa.

The Zoëa is wholly pelagic.

It is a feeding period during which the Pereiopods and Pleopods develop.

Functional Appendages. The Zoëa has a cephalothorax, and abdomen and telson. There is no sharper dividing line between the cephalon and the thorax than there is in the adult. The thorax is only partly developed, two thoracic appendages alone being functional, viz. the First and Second Maxillipedes. The hind part of the thorax, to which pertain the Third Maxillipede and the five Pereiopods, is rudimentary.

The cephalic appendages are all present and functional: they are the Eye, Antennule, Antenna, Mandible, First Maxilla, Second Maxilla.

The abdomen is 5-jointed; the pleopods are rudimentary.

All the functional appendages differ very much from their structure in the adult.

With the exception of the telson they are feeding and sensory organs.

The telson, as Du Cane pointed out, functions mainly in assisting the ecdysis of the integument of the appendages. (*Cp.* the telson in the Zoëa of *Crangon vulgaris*.) The abdomen and telson are also used for intermittent progression. The principal motor organs are the setose exopodites of the first and second maxillipedes.

The Megalops.

The Megalops is the connecting link between the pelagic Zoëa and the demersal young crab. It partakes of the characters of both. It swims by means of its five pairs of pleopods, after the manner of a *Crangon*, and also crawls about on the bottom by means of its pereiopods.

In *Crangon* the Megalops stage persists with slight modifications to be the adult condition. The Brachyura pass through a Crangon stage in the Megalops, and then undergo further specialisation which affects the abdomen alone. The pleopods change in character, they lose the

* "On some Points in the Structure of the Embryonic Zoëa [*Carcinus mænas* and *Panopeus Sayi*]," *Bull. Mus. Compar. Zoology, Harvard*, vol. vi., No. 10, 2 pl., p. 159. Cambridge, Mass., U.S.A.; 1880.

swimming function. In place of five there are in the later stages four pairs of abdominal appendages in the female and two pairs in the male. In both sexes these are now merely sexual organs.

The Larval Characters.

The Protozoëa shows some yellow and brown pigment ; it is the pigment of the I. Zoëa which shows through the delicate cuticle.

The Zoëa of *Carcinus mœnas* is readily distinguished from the other Zoëæ which may be taken along with it in a tow-net collection, made in Scottish waters, by—

(1) The absence of the lateral spine of the carapace.

(2) The colouration.

(3) The structure of the abdominal joints.

On the dorsum of the carapace there is a pair of short hairs situated a little behind the base of the rostral spine (Fig. 159).

(1) The Zoëæ of *Cancer pagurus* and of certain other common Brachyura have a strong lateral spine on the carapace. The carapace in *Carcinus* is plain (*ib.*).

(2) Colouration. The Zoëa of Carcinus has to the naked eye a greenish or olive appearance. On the dorsum just in front of the base of the dorsal spine there is a double blue spot, which by reflected light is brightly luminous. The pigments present throughout the body of the larva are yellow and brown (or black). They are laid down in branching chromatophores, and are associated, the yellow being surface, the black (or brown) deeper. When examined by means of the microscope, the dark pigment is seen to be arranged on the side of the cephalothorax and to pass down the abdomen in a series of large chromatophores located on the ventral halves of the somites. On the cephalothorax and abdomen the yellow chromatophores are associated with the black. Over the cornea there is a reticulation of yellow pigment. The yellow pigment is more or less luminous throughout.

In preserved Zoëæ the black pigment alone is seen, and the large branching chromatophore on the side of the cephalothorax is characteristic.

(3) Abdomen (Fig. 118). The lateral part of the terga of the 2–5 abdominal segments extends backwards in the I. Zoëa in a rounded expansion over the beginning of the succeeding segment. The posterior edge of this plate is minutely notched.

I.–IV. Zoëæ. All the Zoëæ stages show the above characters, though they vary in degree. The pigmentation varies in intensity, some forms showing a much darker greenish appearance to the naked eye than others. The little hairs at the base of the dorsal spine were not made ou in the III. and IV. Zoëæ examined.

The lateral expansion of the terga of the abdominal somites becomes more prominent in the later stages; in shape it becomes more angular (Fig. 129).

The Separation of the Four Zoëa Stages.

Zoëæ of *Carcinus* were obtained of four different stages by means of the tow-net. A certain amount of difficulty was experienced in deciding that there were only four stages in the Zoëa period. This was due to the fact that the Zoëæ of any one stage vary in size and may also vary in structure.

The Protozoëa and I. and II. Zoëæ were hatched out and reared in the Laboratory. The III. and IV. Zoëæ were captured along with I. and II. stages in the tow-net.

The II., III., and IV. Zoëæ obtained from the latter source were kept until they moulted, and the resulting stage was in the case of the first two the III. and IV. Zoëæ respectively; and from the IV. Zoëa the Megalops was obtained. This was the method adopted by Mortensen* in the case of *Palæmon Fabricii*, and later by myself with *Crangon vulgaris*.

The variation in size between Zoëæ of the same stage was also noticed in the case of the Zoëæ of Crangon. Gurney found the same difficulty in the case of the Zoëæ of *Corystes cassivelaunus*, especially in the second stage. He, however, came to the conclusion that there were only four Zoëa stages.

The four stages are fairly widely separated by their sizes. Naked-eye drawings are shown alongside Figs. 159, 148, 147, and 146. They are intended to give a fairly accurate idea of the absolute sizes of the four Zoeæ.

A useful character for separating the different stages is the number of setæ on the exopodite of the first or second maxillipede, but this is not constant.

In the I. Zoëa there are 4 setæ.
„ II. „ „ 6 „
„ III. „ „ 8 „
„ IV. „ „ 10 „

Two cases of III. Zoëa were found which had only six setæ.

The pleopods afford a character by which the III. and IV. Zoëæ can be separated from one another, and also from the I. and II. Zoëæ.

In the I. and II. Zoëæ the pleopods do not project beyond the ventral line of the abdominal somites. In III. and IV. they do so. In III. the pleopods of the second to fifth somites are half the length of the abdominal somite; in IV. they are as long as the somite.

In III. and IV. the pereiopods are large; in the latter they are segmented.

As to the length of the Zoëa period I have no data except that the Zoëa of the first stage which was hatched on May 15th moulted into the second Zoëa between the 24th and 27th of the same month, that is after an interval of not more than twelve days. From this it may be fairly inferred that the Zoëa period does not probably exceed a month.

Characters of the Megalops (Fig. 152) and Early Young Stages.

The Megalops can be readily distinguished from the Megalops of other species. It has to the naked eye a dirty-greenish or olive colouration. Microscopic examination shows the presence of a large black chromatophore on the dorsum, and also that there is no dorsal spine on the carapace. The intensity of the pigment varies.

Its integument is similar in character to that of the Zoëa, viz. very transparent, hyalin.

The abdomen projects in line with the cephalothorax; it has five pairs of functional pleopods.

On the basi-ischiopodite of the chela there is a large hook.

The dactylopodites and propodites of the second, third, and fourth pereiopods have small serrated thorns.

On the dactylopodite of the fifth pereiopod there are three long curved spines.

There is a short rostral spine.

* Mortensen, "Undersogelser over Vor Almindelige Rejes (*Palæmon Fabricii*, Rtk.)." Copenhagen; 1897

The First Young stage (Fig. 167) has none of the characters of the Megalops.

The general form of the carapace and pereiopods has changed towards the adult condition; the lateral teeth of the carapace are now present, though not fully developed.

The integument is not so transparent as in Megalops; it now shows some definiteness of structure; it is not yet calcified. It is, moreover, covered all over the *exposed* surfaces with minute "needle-point" cilia (Figs. 166, 169). They are arranged singly, or in groups of two, three, or four.

The carapace is longer than it is broad.

The abdomen is tucked in under the thorax; the five pairs of pleopods are present in a degenerate condition.

Second, Third, and Fourth (Figs. 173, 170, 171). In the second, third, and fourth stages, with increased bulk, the carapace tends to become broader proportionally. The lateral teeth become more prominent. The eyes become less so.

The minute "needle-point" cilia were found in all these stages. In the fourth stage (4 mm.) they were made out on the dorsum of the carapace.

Crab 5·5 mm. In this crab none of the cilia were found on the carapace. The sexual characters were distinguished at this size.

The cilia therefore apparently disappear between 4 mm. and 5·5 mm.

The sexual characters were not noticed in the ciliated individuals: their examination was not, however, an exhaustive one.

The ciliated stages are probably non-sexual.

Development of the Appendages.

The appendages will be considered in the following order:—(1) Antennule, (2) Antenna, (3) Mandibles, (4) First Maxilla, (5) Second Maxilla, (6) First Maxillipede, (7) Second Maxillipede, (8) Third Maxillipede, (9) Pereiopods, (10) Branchiæ, (11) Telson, Abdomen, Pleopods, (12) Eye.

Antennule, a., Plate vii.

I. (Figs. 2 and 33). The antennule of the first Zoëa is 2-jointed, a short proximal and a long distal joint. It is of cylindrical form, and is slightly curved. It bears at its extremity five sensory tubes; of these two are long, the others short. These tubes are connected directly with the ganglion which is seen occupying nearly the whole of the long joint. When the antennule is examined *in situ* in the cephalic region (Fig. 33), the short first joint appears to be sunk through the integument into the cephalic region.

During the remaining Zoëa stages the number of sensory tubes increases, and the shape of the long joint changes to a pear-shape.

II. (Fig. 3). The aesthetascs (sensory tubes) are six in number; of these one is very short, the others vary in length and thickness.

III. (Fig. 4). In the specimen of the third Zoëa, only five aesthetascs were found, but they were arranged differently from the previous stage; four were terminal, and the fifth arose a little distance short of the tip.

IV. (Fig. 6). There were now seven sensory tubes; four of these were terminal, and the remaining three arose together a little behind the other group.

The first joint of the antennule was not noticed. The shape of the long joint has altered considerably, and it is now constricted at its

middle: a joint was not satisfactorily made out. A swelling has appeared on its distal half. This is the rudiment of the single-jointed process of the Megalops. The ganglion is in the distal half of the joint.

Megalops (Fig. 29). The antennule is now a very different organ. It is 2-branched. The first joint of the appendage in the I. Zoëa is no longer to be made out; it has probably fused with the cephalon. The antennule consists of seven joints, a large basal joint, triangular in shape, representing the broad proximal half of the appendage in IV. Zoëa, and six other joints which represent the distal half of the long joint in IV. The second and third joints are broad, and contain within them the ganglion, now divided into two. The third joint has a broad distal end, from the projecting corner of which a single-jointed appendage arises. The latter joint is tapered, constricted at its middle, and bears four terminal smooth hairs; and two other shorter hairs arise from the joint as shown in the figure. It is the endopodite.

Distal to the third broad joint there are four narrower joints: the fourth, fifth, and sixth are short, the seventh a long joint constricted at its middle. There are three main groups of aesthetascs attached to the last three joints. On the fifth joint there are three; on the sixth, five (in one case four); and on the seventh a group of three about the middle of the joint, and a single one a little short of the end of the joint. On the end of the joint there is a long sparsely ciliated hair.

There are several short hairs distributed over the other joints: these are shown in the sketch.

The first joint contains the auditory organ, for a minute description of which *see* Hensen's* and Prentiss'† papers.

The sensory tubes are connected by tubes with the ganglion, which is not single but composed of different ganglia, which appear to serve different aesthetascs or groups of aesthetascs. The compound ganglion is situated in the second and third joints. From the position of the ganglion we are able to homologate the different portions of the antennule of the Megalops with that of the IV. Zoëa. The lower half of the long pear-shaped joint becomes the first joint of the Megalops; and the remaining six joints and the short appendage from the third joint are derived from the distal half of IV. The little 1-jointed appendage is the endopodite: the aesthetasc-bearing appendage is the exopodite.

In *Carcinus* we have an exactly similar condition to what is found in *Crangon vulgaris*.‡ In the latter the auditory organ is in the first joint; the compound ganglion is located in the second and third joints, and from the the third joint arise an exopodite [3-jointed] bearing groups of aesthetascs, and an endopodite [2-jointed] bearing hairs only. In *Crangon*, however, the antennule in the VI. stage (Megalops) is straight, whereas in *Carcinus* the antennule is bent over on itself.

1. (Figs. 18, 20, 21.) In the first young stage the condition is practically identical with that of the Megalops, except that with increase in size the joints are more numerous. The first three joints are unchanged, except in size, but the terminal joint of the exopodite is now segmented, and the 1-jointed endopodite is now 2-jointed. That is, the antennule has now eight joints, with a 2-jointed endopodite rising from the third joint. The endopodite and exopodite are bent down towards the third joint.

* Hensen, "Studien über das Gehörorgan der Decapoden," *Zeitschr. f. wissenschaft. Zoologie*, Bd. 13, p. 319; 1863; 4 Taf.

† Prentiss, "The Otocyst of Decapod Crustacea: its Structure, Development, and Functions," *Bull. Mus. Comp. Zoology, Harvard* vol. xxxvi., No. 7, 10 pl. Cambridge, U.S., A., 1901.

‡ *Op. cit.*

The number of aesthetascs was found to be—four in the proximal group, four in the next, three in the distal, and beyond that group a single aesthetasc arose from the middle of the end joint.

The exopodite bears a long smooth terminal hair.

A few minute "needle-point" cilia were found on the second joint.

ANTENNA, A., Pl. vii.

I. (Fig. 16). The antenna of the I. Zoëa consists of a single basal joint which is produced distally into a long spine, serrated on both sides (Fig. 1, *b*). At the distal end of the joint there articulates a branch consisting of a long narrow joint which bears two smooth spines, one very long, the other short. The distal end of the long joint is serrated (Fig. 1, *a*), and the short spine rises from a projecting corner of the same. This branch is the exopodite, and it is the homologue of the scale of the antenna of *Crangon vulgaris*. It is present in the Zoëa, but absent in the adult.

The serrated process is the endopodite, and from it is developed the flagellum, *i.e.* the antenna of the adult. On the proximal part of the process there is a swelling (*sw*, Fig. 16), which is the rudiment of the flagellum. During the succeeding Zoëa stages it grows in size alongside but quite independently of the serrated process. In this respect *Carcinus* differs from *Crangon*. In the latter the serrated process develops into the flagellum. The future whip first appears in the wide proximal part of the process, and as it grows it absorbs the serrated portion till the latter becomes merely a tuft of hairs on the end of the former. In *Carcinus*, however, in the IV. or last Zoëa stage the serrated process is as large and important proportionally as in the I. Zoëa.

The serrated process in both forms is a character of the Zoëa alone.

During the succeeding Zoëa stages, development in the antenna takes place only in the bud of the flagellum, the other parts remain unchanged in form, though they increase in size.

II. (Fig. 17). The rudimentary flagellum is now prominent as a conical protuberance.

III. (Figs. 4, 5). The flagellum is now half the length of the serrated process.

IV. (Fig. 6). The flagellum is now almost as long as the serrated process. The exopodite has diminished in relative size.

MEGALOPS (Fig. 11). The antenna now has its adult form. It consists of nine joints, the first three are wider than those that follow. The latter, with one exception, viz. the fourth joint of the antenna, are long narrow tapering joints. The antenna is furnished with two prominent long smooth stiff hairs. They arise from the distal end of the seventh joint. With them are associated two short hairs. The terminal joint bears three stiff smooth slender hairs, and round the distal edge of the fifth joint there is a ring of four short hairs. On the third joint there is one short hair, and on the first joint there are three similar hairs. In another Megalops the antenna had only eight joints, the fifth and sixth joints of the form drawn being fused together. The first joint of the antenna appears to be the protopodite, and is probably the homologue of the basal joint of the antenna of the Zoëa.

1. (Figs. 7, 21, and 23). In the first young stage there is little change from the condition in the Megalops. Considerable variation was found in the antennæ of different individuals. In one (Fig. 7) there were ten joints; the arrangement of hairs was practically the same, except that a joint seemed to have been added to the first three joints, so that

the little rounded joint bearing the single hair is now the fourth, instead of third as in the Megalops, and also in another first young form. In Figs 21 and 23 the antennæ of the right and left sides of a first young stage specimen are shown. In Fig. 23, however, the first two joints are not given. The antenna of the right side is incompletely developed. This may be in consequence of an injury, and the part may be in process of reproduction. The antenna of the left side was 9-jointed, but had not the two long hairs on the seventh joint.

The first joint shows a recess in its outer surface, and behind it a tooth. A few more hairs are found on the first joint, and some of these are ciliated.

The first three joints have scattered over their surfaces minute "needle-point" cilia, which are arranged singly or in groups of 2, 3, or 4. These cilia are an important character in the first young stage.

MANDIBLE, mn, Pl. vii.

I. (Fig. 8). The Mandible is 1-jointed. It consists of two distinct parts, a cutting edge (*e*), and a massive crushing crown (*cr*). Alongside the crown a large triangular tooth (*t*) rises in line with the cutting edge. There is no palp. Spence Bate drew attention to the resemblance between the mandible of the Zoëa of *Carcinus* and that of an amphipod.

II. (Fig. 24), III. (Fig. 22), IV. (Fig. 9). In the remaining Zoëa stages the mandible retains the characters of the I. Zoëa.

MEGALOPS (Fig. 26). The mandible is now very much changed. The cutting edge ends in a prominent stout angle. It has a rounded cutting edge and a 3-jointed palp. The palp (Fig. 26, *b*) has on its end joint a series of seven stout short hairs, which are provided with stiff cilia (Fig. 27). The palp arises from the upper side of the mandible.

I. (Fig. 10.) The inferior corner of the cutting edge is turned up, The hairs on the palp have increased in number. Otherwise the mandible is little changed. The figure shows the upper surface.

Labrum, *lr*. *Labium*, *lb*. Plate vii.

The labrum of I. Zoëa is shown in Fig. 33; the labium is seen in Fig. 25.

FIRST MAXILLA, 1m, Plates vii. and viii.

I. (Fig. 14). The first maxilla has a 2-jointed protopodite. The inner edge of each lobe is furnished with toothed spines. Rising from the second joint there is a 2-jointed palp.

The palp bears at its extremity six stiff blunt hairs, one of which has on its proximal half a few long cilia. Of the others one or two are minutely serrated (Fig. 34, *a*). There is a similar hair on the first joint of the palp.

The spines on the protopodite lobes are strong, with large teeth or stout lanceolate cilia. On the upper lobe there are five spines; on the lower lobe there are seven. The latter are provided with long lanceolate cilia, as are also certain of the spines of the upper lobe. Figs. 31, 32, and 34, *b*, *c*, are spines of the protopodite lobes. The spines are similar to those found on the first maxilla of the Zoëa of *Crangon vulgaris*.

On the lower edge of the upper lobe there were three groups of cilia. They were not noticed in the other Zoëa stages.

II. (Fig. 37). The first maxilla has gained a number of spines, eight being present on each lobe. On the outer edge of the upper

lobe there is a short plumose seta, and on the inferior edge a short plain hair.

III. (Figs. 35 and 38). The condition is similar to the preceding. The little plumose hair which is seen on the outer edge of the upper lobe is shown in Fig. 12.

Fig. 15 is an enlarged drawing of the palp.

IV. (Figs. 13 and 36). In this stage one spine more was found on the upper lobe, and one fewer on the lower lobe than in III., *i.e.* ten on the upper and seven on the lower.

In the specimen dissected the two first maxillæ were not alike. The palp of one side was normal (Fig. 13), while the palp of the first maxilla of the other side had a single hair attached to the middle of the second joint (Fig. 36), in this recalling the structure of the palp of the first maxilla in the Megalops of *Crangon vulgaris*.

Megalops (Fig. 47). The first maxilla in this stage retains a general resemblance to the Zoëa condition. It is 2-jointed. From the basal joint rises a narrow lobe. The second joint forms a large lobe, on the outer side of which there is the palp. Except for an increase in the number of spines on the two lobes their armature has not changed much.

The palp, however, is now a single-jointed flattened appendage, which is bent on itself.

In this specimen also the two first maxillæ differed, viz. in the number of spines on the lobes.

1. (Fig. 42.) The palp is now 2-jointed. The first joint is broad and peculiarly shaped; it bears two smooth hairs at its middle. The second joint is bent down away from the lobes, and carries two terminal smooth hairs.

The armature of the two lobes is shown in the sketch.

Second Maxilla, 2m, Plates viii. and ix.

The second maxilla consists of two joints, *vide* Fig. 55, which shows the appendage in the IV. Zoëa. The first joint (*prot. ib.*) has a long lobe (l') attached to it. This appears to be simply a process of the first joint, not segmented off from it. The upper joint is cleft into two lobes (l'', and l'''). To its outer edge is attached the scaphognathite which is the homologue of the palp in the first maxilla. There is then in the second maxilla a condition similar to that of the first maxilla. Gurney in his drawing of the second maxilla in the I. Zoëa of *Corystes* indicates a condition resembling that described above. It is possible that the top lobe (l''') is the endopodite, but in none of the stages was it seen to be segmented off.

I. (Figs. 45 and 76). The endognath then consists of three lobes, of which the two upper form the large lobe, and the third the small lower lobe. Each lobe bears on its inner edge a number of bristles, which are grouped on sub-divisions of the lobes. The spines on the upper double lobe are long stiff hairs, some of which are provided with a few long lanceolate cilia, others are minutely serrated on their distal halves (Figs. 44 and 54). On the lowest lobe the spines are adorned with long lanceolate cilia (Fig. 50). The spine formula is $(5 + 3 : 4 + 5) : (4 + 3)$. Certain of these resemble spines that are found on the first maxilla.

On the upper and lower edges of the lobes there are groups of delicate cilia.

The scaphognathite is small and bears five long plumose setæ. The same number was found by Gurney in *Corystes* and by Mortensen in *Palæmon Fabricii*. In *Crangon vulgaris* also there are five setæ.

II. (Fig. 39). The number of spines found on the second maxilla drawn was (5 + 3 : 4 + 5) : (3 + 3).

The scaphognathite had nine plumose setæ.

III. (Fig. 61). The spine formula found in this example was (5 + 3 : 5 + 5) : (4 + 3).

There were 18 plumose setæ on the scaphognathite.

IV. (Figs. 40 and 55). The spine formula was (5 + 3 : 5 + 5) : (4 + 3).

In III. and IV. Zoëæ then there is one spine more than in I. Zoëa.

The scaphognathite bore 24 setæ.

Megalops (Fig. 46). While the general form remains similar, the second maxilla has changed greatly in the proportions of its several parts. The scaphognathite, which during the Zoëa stages was rapidly growing larger, constitutes now the greater part of the appendage. The prominent spines of the Zoëa are now replaced by short smooth stiff hairs.

The 2-jointed structure of the second maxilla is still evident. The large top lobe has become differentiated into two parts, the upper of which is a conical process devoid of hairs, the other a bifid lobe bearing the short smooth hairs. The lower lobe is more deeply cleft; on its upper half it bears two short smooth hairs, and on its lower, four hairs, one of which is provided with several long cilia, while a second has one or two serrations.

The numbers of hairs on the endognath are as follows: (0 : 3 + 3 : 3 + 4) : (2 : 2 + 2).

The scaphognathite bears 39 short plumose setæ.

On the surface of the scaphognathite there are three little hairs, and on the middle lobe of the endognath, two similar hairs.

1. (Fig. 59). The top division of the endognath now bears a single stiff hair at the middle of its length. The hair arrangement is (1 : 2 + 4 : 6) : (3 + 4).

Of the four hairs on the bottom part of the lower lobe, three are ciliated.

The middle portion of the endognath is now segmented off from the rest of the appendage.

The number of short plumose setæ fringing the scaphognathite is largely increased. On its surface a few short hairs were noticed.

The Maxillipedes, mp, Plates viii., ix., x.

In the Zoëa two maxillipedes only are functional, viz. the first and second pairs. They act as feeding organs, and also through the action of their seta-bearing exopodites, serve as the principal organs of locomotion. The third maxillipede is not fully developed until the Megalops stage.

Spence Bate stated that "at the base of these two last pairs of appendages [2nd and 3rd maxillipedes] the germ of the future branchiæ may be distinguished."

When the first and second maxillipedes are examined *in situ* the protopodite appears to consist of three joints (fig. 76). This, in view of Hansen's* theory of the 3-jointed protopodite, is of some moment. Two of the joints—viz., the long joint and the short one proximal to it—are distinct. The "joint" connecting the latter to the thorax is tapered, and it is an open question whether it is really a joint of equal

* Hansen—"A Contribution to the Morphology of the Limbs and Mouth-parts of Crustaceans and Insects," *The Annals and Magazine of Natural History* VI.), vol. xii., 1893, p. 417.

value to the two others. It appears rather to be a bundle of muscles enclosed in a thin chitin. I have not satisfied myself that it is a true joint and in the following description have neglected it.

FIRST MAXILLIPEDE, 1 mp, Plates viii. and ix. (Fig. 78).

I. (Figs. 57, 76, and 85). The first maxillipede consists of a 2-jointed protopodite. The first is short, the second is a long joint. To the latter are attached the endopodite and the exopodite.

The exopodite is a 2-jointed branch bearing four long densely plumose setæ. Two of these are terminal, and two arise, one on each side, a little behind the former.

The endopodite is 5-jointed, and is furnished with a number of long serrated hairs. On the end joint (Fig. 78) there are four serrated hairs and a short smooth hair. On the second joint there are two of the former, on the third joint one, and on the second and first, two hairs each.

The protopodite has a number of smooth hairs. Two arise from its inner edge close to the base of the endopodite. Six more are found on other parts of the inner edge. The formula of the arrangement of hairs on the protopodite and endopodite was, 0 : 4 + 2 + 2 : 2 : 2 : 1 : 2 : 1 + 4.

II. (Fig. 51). With an increase in size little difference is found in this stage.

There is an extra hair on the second joint of the protopodite, and certain of the hairs on it have a few short cilia.

The exopodite has now six plumose setæ, the two new setæ having been added one on each side and a little behind the original four.

III. (Fig. 53). The principal change in this stage is the addition of two more setæ to the exopodite, making in all eight setæ. *Vide* Fig. 52, which shows the end of the exopodite, side view.

In two Zoëæ which from the stage of development of the pereiopods and pleopods evidently belonged to this stage, viz. the III., the exopodites of the first and second maxillipedes had six swimming setæ.

On the first joint of the protopodite in this stage a small process was seen which is the epipodite (*ep*).

IV. (Fig. 41). The exopodite has now ten swimming setæ. In *Corystes* (Gurney) the exopodite had in this stage twelve setæ. An additional spine was found on the last joint of the endopodite.

The hair formula was, 0 : 6 + 2 : 2 : 2 : 1 : 2 : 4.

The epipodite (*ep'*) is now large and prominent (Fig. 67).

MEGALOPS (Figs. 43 and 49). The first maxillipede now approaches the adult condition.

The protopodite is 3-jointed. The first joint bears the epipodite; it is the first joint in the Zoëa. The second and third joints, *M*, represent the single long second joint of the Zoëa.

The endopodite is a 1-jointed hammer-shaped flattened process, bearing on its upper edge three short smooth hairs.

The exopodite is 2-jointed, and is bent at a right angle. On the distal end of the first joint it has usually two plumose setæ, sometimes, as in the example drawn, one only. The second joint shows a line crossing it obliquely, which indicates a rudimentary joint. It bears four plumose setæ.

The second and third protopodite joints are furnished along their inner edges with a number of hairs, some of which are ciliated (Fig. 49).

The epipodite, which is a process of the first joint, bears eight long thin slightly curved hairs. They are stiff, and are found mainly on the outer edge. On the "heel" of the epipodite is a pair of smooth hairs.

I. (Figs. 48, 58, and 60.) In this stage the first maxillipede has altered considerably. The protopodite joints are no longer distinct.

The exopodite is 3-jointed. It is furnished with four terminal setæ and a hair close to the tip. The "elbow" joint is not a movable one.

The endopodite (Fig. 60) has a peculiar form. It is twisted on its long axis, and has a flat broad extremity upon which there are eight short smooth hairs. Its inner edge bears three short hairs, of which two are plumose.

The protopodite lobes (Fig. 58) are now long and narrow. They are profusely supplied with spines, of which three of different kinds are shown in Figs. 56, 62, and 63.

The epipodite has more filaments. Of these 13 are on the outer edge, four on the inner edge of the proximal half, and one on the surface of the latter. On the "heel" there are three stout serrated hairs.

SECOND MAXILLIPEDE, 2 mp, Plates viii. (Fig. 51) and ix.

I. (Figs. 68, 76, 83 and 85). The second maxillipede resembles the first maxillipede, but differs from it in the size of its endopodite.

It has the 2-jointed protopodite, a 2-jointed exopodite which bears four plumose setæ, and a 3-jointed endopodite.

On the long protopodite joint (the second) there were on the inner edge four hairs, of which two had a few cilia.

The endopodite (Fig. 83) bears on each joint a strong serrated spine, that of the third joint being the longest, while that of the first is the shortest. On the end joint there is in addition a long slender hair and three shorter hairs. The former and one of the latter show a single serration each.

The hair formula was, 0 : 4 : 1 : 1 : 5.

On the first joint of the protopodite a rudimentary epipodite was made out (*ep*, Fig. 85).

II. (Fig. 51). In this stage there is little that calls for special mention, except that the hairs and spines are with one exception all serrated.

The exopodite has six plumose setæ.

III. (Fig. 65). The endopodite showed on its last joint six hairs (Fig. 70), *i.e.* one more than in the two preceding stages.

The endopodite has eight plumose setæ.

IV. (Fig. 66). In this case the same number of hairs was found on the endopodite as in the I. and II. Zoëæ.

The plumose setæ of the exopodite are now ten in number.

The epipodite (*ep*) on the first joint of the protopodite is now large, as is also another process which is a branchia (*br*).

MEGALOPS (Fig. 64). The protopodite is 2-jointed, and from the first joint arise a branchia (*br*) and the epipodite (*ep*). It is probable that another branchia is present, but it was not made out. The protopodite joints are broad and short. The second is the homologue of the long second joint in the Zoëa.

The exopodite is 2-jointed, and the second or distal joint shows a line of segmentation across it. At the elbow there is a thickening of the integument, probably strengthening. The exopodite has four plumose setæ.

The endopodite is 5-jointed and bent. The last two joints are armed with stout serrated spines. On the fifth joint there are five serrated spines and two smooth hairs, on the fourth two serrated spines and one smooth hair, and on the third and second joints one smooth hair each.

The epipodite is small and has no filaments.

1. (Fig. 71.) The appendage is now more specialised. The protopodite joints are no longer distinct, but fused.

The epipodite is still small and without filaments.

The branchia shows a little segmentation.

The 5-jointed endopodite retains the character of the preceding stage, but its first and second joints have now a number of ciliated hairs. Enlarged drawings of two of the spines on the fourth and fifth joints are shown in Figs. 75 and 87.

The exopodite is of three segments. The first is broader and bears on its outer edge an expanded plate-like ridge, the edge of which has a series of teeth. On its proximal part there are two short plumose hairs. Distal to these there are five curved teeth, three of which have little lateral teeth, while the remaining two are plain (Fig. 71, *a*). Opposite the upper part of the ridge there are two similar teeth. The third joint bears five plumose setæ and a plain hair.

Third Maxillipede and Pereiopods.

The third maxillipede and the five pereiopods are not functional in the Zoëa stages; they are found in the I. Zoëa as buds, forming with the diminutive sternum region pertaining to them a hemispherical mass situated between the bases of the second pair of maxillipedes and the first abdominal segment. The mass lies as it were in a cup-shaped depression. It is seen in side view in Fig. 76, and in ventral view in Fig. 85. The sternal region is an oval plate or disc, and is surrounded on both sides by the closely-packed buds of the third maxillipedes and pereiopods. The sternum shows some indication of segmentation.

The buds of the third maxillipede and pereiopods were shortly described by Spence Bate as follows (*p. 593*):—"Posterior to the last pair of members that I have described [maxillipedes], several sacs are visible. These evidently contain the germs of the five pairs of pereiopoda, or true ambulating legs, the most anterior of which I think I have been enabled to perceive lying folded within the sac, as shown in *Plate XL., Fig. 10.* Some of the small sac-buds probably are the germs of the future branchiæ, and it is not improbable that in the embryonic condition they fulfil the object of their design sufficiently well for so immature a creature."* That respiration is carried on by the buds of the gills is not at all likely.

In tracing the development of the branchiæ it will be shown that, during the present research, conditions were observed partly in agreement with the view expressed by Hansen regarding the connection between the limbs and the branchiæ. According to that author, the explanation of "the fact that in the Decapods branchiæ are found upon the pleuræ, upon the arthrodial membrane between the pleuræ and the limb, and also upon the coxopodite," is to be found in the view that "the portion of the pleuræ provided with branchiæ is to be regarded as originally belonging to the limb, so that we now find its vanished segment represented by branchiæ alone."

Third Maxillipede, 3mp, Plates ix. and x.

I. (Figs. 69, 76, and 85). The third maxillipede is a bifid bud; the branches are of unequal breadth; the narrower is the exopodite. On the outer surface there are two swellings; the smaller, which is distal, is the

* *Op. cit.*

future epipodite, the large proximal swelling represents two branchiæ. No segmentation into joints was seen. The limb is a hollow process, and the swellings are also hollow.

II. (Fig. 84). Three swellings are now to be made out on the outer side of the growing bud. The upper represents the epipodite, the other two, branchiæ.

III. (Fig. 74).

IV. (Fig. 67). The endopodite is a 3-jointed branch. The epipodite (*ep*) is large, and the two gills are seen to be hollow swellings.

Megalops (Figs. 81, 86, and 87). The appendage is now functional. There are two basal joints, the first a thin joint, the second is a large joint bearing the epipodite. Attached to the upper part of the first joint, or probably actually in position as arthobranchs, there are the two branchiæ, not yet functional, however. Above the base of the epipodite there is a small process which is probably the future podobranch.

The epipodite (*ep*) has eight long stiff filaments, which are curved at their tips. They are with one exception on the outer edge of the epipodite. On the beginning of the epipodite there are three plumose hairs.

The large basal joint is adorned with a row of six plumose hairs.

The exopodite is 3-jointed and bears four plumose setæ at its extremity. The exopodite is bent, and the "elbow" joint is strengthened by a thickened chitinous plate on the external angle; it appears to be rigid.

The endopodite is 5-jointed, and is bent on itself. The first joint is a long flat joint, broader distally than at the proximal end (Fig. 97). Its internal edge is a little irregular, and it has three little angular projections. It is furnished with short hairs, of which some are ciliated; they are mainly located on the edge: a few are surface in position. The second is a broad rounded joint, narrower than the distal part of the first joint. It is provided with a number of hairs, of which two are serrated (Fig. 81). The remaining three joints are armed with serrated bristles, the terminal one of which is very long and stout (*ib.* and Fig. 77). All the serrated bristles are on the anterior or upper surface, *that is*, next the second maxillipede. There is a considerable amount of free movement in an antero-posterior plane at the joint between the second and third segments. The other joints give little or no movement.

1. (Figs. 88, 98, 103). In this stage no important difference from the preceding stage is noted. The three branchiæ are present, two of the branchiæ are lobed. The epipodite has an increased number of filaments. The basal joint and the proximal end of the epipodite are adorned on the posterior surface with, in the case of the former, two rows, and in the latter, one row of plumose setæ. Alongside the plumose setæ there is a row of little thorn-like teeth.

The exopodite (Figs. 88 and 98) is 3-jointed, and has five plumose setæ. On the inner edge of the exopodite there is, near its distal end, a notch. The exopodite moves about on the superior or anterior surface of the endopodite, and this notch, into which the hind edge of the second joint of the endopodite fits, prevents the exopodite from moving too far over the endopodite. There is in the adult a similar notch on the exopodite of the third maxillipede: it is accompanied by a tuft of hairs.

Two drawings of the endopodite are given; one, (Fig. 98) represents the upper or anterior surface, the other (Fig. 103) shows the posterior or ventral surface. The latter is covered over with minute needle-point cilia, which have been already noticed as parts of the antennule and antenna in this stage. On the third, fourth, and fifth joints of the

endopodite, these cilia are only on the dorsal half of the surface. This is the exposed surface of the third maxillipede. The upper surface is close up against the second maxillipede, and on it (the upper surface) there are none of these cilia. Generally over the body of the crab of this stage the external surfaces are covered with these minute cilia, except where two surfaces interact on one another, *e.g.* anterior surface of chela on the epimeron. In the third maxillipede they are not confined to the endopodite, but are also on the basal joint, and on the part of the first joint of the exopodite which is exposed beyond the endopodite.

The two sketches together show all the hairs and bristles which are found on the appendage. A number of these, however, appear in both drawings. They are those on the superior edge of the second and third joints, and the short hairs on the edge of the first joint.

The inner edge of the first joint of the endopodite is now minutely crenate: the exact number of lobes is shown in the sketch. It is furnished with a row of short hairs, all situated on the outer surface. On the surface of the joint there are externally a number of plumose hairs, and on the internal surface a number of hairs of which only one was made out to be provided with cilia (two).

The second joint has a notched superior edge, and on its inner side it is hollowed out to receive the third joint; the hinge between the two gives a free movement antero-posteriorly.

The number of serrated bristles on the third, fourth, and fifth joints has increased. They are all on the superior surface, *i.e.* next the second maxillipede.

The Pereiopods, per, Plates ix., x., and xi.

I. (Side view, Figs. 69 and 76; ventral view, Fig. 85). The pereiopods in the first Zoëa stage are hollow buds packed closely together on each side of the oval-shaped rudimentary sternum (*th*). They are all more or less club-shaped, the first pereiopod being distinguished from the others by its greater size and swollen end. The remaining buds resemble one another much. They are arranged round the sternum, and on account of the oval form of the latter the fifth pereiopod is brought round nearer the median line than the others. It is in this way often hid when the buds are examined in side view.

The buds of the branchiæ (*br*, Fig. 69) are seen in this stage. There is a large hollow outgrowth from the outer side of the first pereiopod, and two small similar buds from the outer sides of the second and third pereiopods respectively. The hollow interior of the bud of the branchia is continuous with that of the pereiopod bud: this is seen better in the later stages.

The buds of the pereiopods show no segmentation.

The sternum of that part of the thorax is rudimentary like the limbs that pertain to it, and it separates easily off as an oval disc: it shows some traces of segmentation.

The gut in this part of the Zoëa is interesting. The gut is in the adult straight, and so it is in the Zoëa except at this part, where it is convoluted (Fig. 162, Plate xii.). The convolutions allow for the gradual expansion of this region with its growth during the Zoëa period, without any extra growth having to take place in the gut which is functioning.

II. (Figs. 73 and 84). The bud of the first pereiopod is now bifid. The hollow structure of the pereiopods is well seen in Fig. 73. They have thick walls.

III. (Fig. 74). The buds have grown rapidly. There is an indication of a basal joint being segmented off on the chela. In one example also the dactylopodite was segmented off on the chela.

IV. (Figs. 67, 79, and 82). The pereiopods are now segmented. The first joint consists of the proximal part, *i.e.* the future pleuron. The jointing is distal to the gills in the first three pereiopods (Figs. 67 and 79). Beyond that there are five segments. The pereiopod is divided into six joints, in which the first becomes the pleuron (*ap*, *ib.*), and the remaining five joints form the adult pereiopod. The complete segmentage into six joints was not found in every IV. Zoëa, *e.g.* in Fig. 82 only five joints were made out.

Megalops (Figs. 89, 90, 93, 95, 105, 106). In this stage all the pereiopods are functional. The 6-jointed state of the previous stage is now replaced by a 7-jointed condition, in which the first joint is the pleuron, and the remaining six form the walking limb, the joints being the coxopodite (*cox*), basi-ischiopodite (*b-isch*), meropodite (*mer*), carpopodite (*carp*), propodite (*prop*), and dactylopodite (*dact*), Fig. 90. The basi-ischiopodite is so named from the view that it represents the union of the basiopodite and ischiopodite joints of the walking limb of the Macrouran.* It is interesting that no such union is shown in its development. Instead of any reduction taking place in the number of joints, the resulting number is the maximum amount of segmentation through which the limb passes. It is probable that the basi-ischiopodite joint is segmented off from the third joint in the IV. Zoëa (*i.e.*, counting the pleuron as the first joint).

The pereiopods in the Megalops have certain characters which belong to this stage and which vanish in the next stage. These consist in a large hook on the distal part of the basi-ischiopodite of the chela, short toothed spines on the dactylopodite (and propodite) of the second, third, and fourth pereiopods, and the long curved spines which so well characterise the dactylopodite of the fifth pereiopod.

The drawings of the 1-5 pereiopods—viz. Figs. 106, 95, 93, 89, and 105 respectively—do not show the whole limb, but simply that part distal to the fracture plane, which occupies the same position as in the adult, (on the proximal part of the basi-ischiopodite). The differences between the limbs are found on these parts. Fig. 90, however, shows the complete fifth pereiopod, and Fig. 101 is an enlarged drawing of the coxopodite and basi-ischiopodite joints. There is little difference to remark between the coxopodites of the pereiopods except that of size (Fig. 149, Pl. xii.). In the preserved specimen the limb breaks off readily at the fracture plane: this is especially the case where the Megalops or young crab has been killed in the preserving fluid.

All the limbs are well furnished with smooth hairs. The coxopodites have a few hairs, which are usually plumose (Fig. 101).

1st Pereiopod (Fig. 106). The first pereiopod is a functional chela. The basi-ischiopodite joint is expanded at its distal inner border into a strong curved hollow hook. Spread over the different joints are the short hairs shown in the sketch; the propodite and dactylopodite are profusely supplied with these (Fig. 109). Along either side of the "knife-blades" are three (or two) of the short stiff curved hairs which were found in a similar situation on the chela of the VI. (Megalops) stage of *Crangon vulgaris*. The knife-blades are crossed by what appear to be little tubes; a bundle of these is seen in the claw termination of each jaw. In connection with similar tubes found in the chela of *Crangon*, it was suggested that possibly by these a lubricant of some

* Léon Fredericq.

sort is poured out on the blades. The other hairs on the hand midway between the blade and the edge resemble those close to the latter in being stouter and less tapering than the hairs on the margins of the hand, dactyl, and other joints. When the jaws are closed their hook terminations cross over one another and interlock.

2–5 Pereiopods. In general appearance the remaining four pereiopods resemble one another much, but they are at once separated into two groups. The fifth pereiopod is easily distinguished from the others by the presence of the long bristles on the dactylopodite. It is moreover considerably smaller than the other three. The second, third, and fourth limbs on careful examination show distinctive characters by which each may be recognised apart from the others.

The number and arrangements of the hairs which were found on each limb are shown in the drawings: it is only necessary to draw attention to the distinguishing marks. They are found on the dactylopodite and propodite. In the second (Fig. 95) and third (Fig. 93) pereiopods there are on the under surface of the dactylopodite three toothed spines. The integument where these are attached is thickened and strengthened (Figs. 94 and 92). On the distal lower corner of the propodite there is another of these toothed spines (Figs. 91, 93, and 95). In the fourth pereiopod the last-mentioned toothed spine is absent (Figs. 89, 99). The latter appendage is by this fact separated from the second and third pereiopods. The second pereiopod may be readily distinguished from the third by its possessing a long spine (*sp*) on the dorsal surface of the dactylopodite (Fig. 95).

The hairs found on the fifth pereiopod are shown in Fig. 105. A little way short of the tip of the dactylopodite three long curved bristles are attached to the lower edge of joint (Fig. 102). The stoutest bristle is, on its last third, furnished on the inner side of its curve with a double row of teeth (Fig. 96); in one row the teeth are very large, in the other much smaller. The longest bristle is more slender than the preceding, and is minutely serrated at its tip. The short bristle is smooth.

1. (Figs. 100, 113, 111, 116, 108, and 110.) The pereiopods have changed considerably. The large hook is absent from the chela, and the propodite and dactylopodite have no toothed thorns. The fifth pereiopod resembles the second, third, and fourth. They are still, however, very different from those of the adult stage.

All are profusely supplied with hairs, plain and ciliated; they are also covered with the minute "needle-point" cilia. The anterior surface of the chela has comparatively few of these little teeth. On the coxopodite, basi-ischiopodite, meropodite, carpopodite, the "needle-point" cilia are restricted to the borders of the joints. There are few near the jaws; some are found on the hand. The posterior surface is thickly covered, with the exception of the greater part of the dactylopodite. On the other pereiopods the "needle-point" cilia are present on both sides.

The sparsely plumose (or ciliated) hairs on the limbs (Fig. 107) have the cilia arranged all round the stem of the hair.

The chela (Figs. 100 and 113) is very thickly provided with ciliated hairs. The posterior surface is shown in Fig. 100 and the posterior in Fig. 113. The knife-blades are not exactly on the same level, so that they pass on to one another when the jaws are closed. The hinge of the dactylopodite is seen in Fig. 115. On the carpopodite there is a hooked tooth (Fig. 133).

There are in this stage no marks such as served to distinguish the limbs from one another in the Megalops; minute differences which have

escaped notice may be present. The fifth pereiopod is the shortest; the propodite joint is shorter than in the second, third, and fourth limbs. The hairs on the dactylopodite are longer in the former than in the latter.

As in the previous stage, only the part of the limb distal to the fracture plane is shown in most cases. Fig. 126 shows the complete fifth pereiopod, and Figs. 123 and 140 show two views of the coxopodite and proximal part of the basi-ischiopodite of the chela. Fig. 114 represents an enlarged drawing of the coxopodite and basi-ischiopodite of the fifth pereiopod.

Branchiæ, br.

The branchiæ, as Claus* pointed out, are all appendages of the limb, and the positions which they occupy on the developing limb determine them as the future podobranchs, arthrobranchs, or pleurobranchs. In this connection, Claus wrote as follows:—"An jener entsprechen die drei übereinander sprossenden Kiemenknospen jedes Somiten gar nicht dem sinne der Huxley'schen Nomenclatur, sondern gehören dem langgestreckten Basalglied an, von dem sich erst nachher der distale Theil als Coxalglied absetzt, während der proximale mehr oder minder weit in die Wandung des Rumpfes aufgenommen wird."*

Compare also, in this connection, E. L. Bouvier:—"Sur le developpement embryonnaire des Galatheides du genre Diptychus." *Comptes Rendus Acad. Sc. Paris.* cxiv (1892).

The branchiæ are not functional in the Zoëa stages. During the Zoëa period they are developing, and in the Megalops certain of them are functional. These are the two arthrobranchs attached to the chela and the two pleurobranchs of the second and third pereiopods; they are completely cut up into lobes. The other gills—viz., those of the second and third maxillipedes—are not yet lobed.

I. The rudiments of most of the gills can be seen in the I. Zoëa, they are all parts of appendages. The future branchiæ of the third maxillipede and of the pereiopods are all hollow outgrowths of he hollow rudiments of these appendages. In the I. Zoëa, then, we have the beginnings of the future arthrobranchs and pleurobranchs. On the third maxillipede and the chela are the buds of arthrobranchs, and on the second and third pereiopods buds of pleurobranchs. In Fig. 69, Pl. ix., a drawing of these is given. It is there seen that the gills of the second and third pereiopods (*br''*, *br'''*) arise from the basal part of the limb-bud, while the large gill-rudiments of the chela (*br'*) and of the third maxillipede (*br*) arise farther up the limb-bud. In the former couple we have pleurobranchs, in the second arthrobranchs. The pleuron of the adult is formed out of the basal part of the limb; and this basal portion includes the gill in one case, and ends just at the gill in the other, so that the gill occupies a position between the limb and its basal part (pleuron).

The large swellings of the third maxillipede and of the chela become each a pair of arthrobranchs.

In one view of the second maxillipede (Fig. 85) a process of the first protopodite joint was seen (*br ?*). It may be the rudiment either of a gill or an epipodite, or what is not unlikely, of both.

II. (Figs. 84 and 73). In the II. Zoëa, on the third maxillipede there are now three swellings—the top one, an epipodite, the lower two, gills. The gill of the chela is still single.

* Claus, "Neue Beiträge zur Morphologie der Crustaceen." *Arb. a. d. Zool. Instit. Wien*, T. vi., 1886. 6 Taf., p. 1.

The continuity between the cavity of the limb and that of the gill is well seen in this stage.

III. (Fig. 74). The gill of the chela is now double.

IV. (Figs. 67 and 79). The separation of the limb into its basal part (pleuron, *ap*) and the limb proper has taken place, and the gills of the pereiopods are, although not yet functional, now large, and show their relation to the limb proper.

The epipodite and two gills of the third maxillipede are well developed.

The process on the second maxillipede which was noticed on the I. Zoëa is now prominent (Figs. 66, 67, and 174). It represents probably the epipodite and one gill.

Megalops (Figs. 80, 64, and 86).—The gills connected with the pereiopods are now functional, and they occupy the positions they do in the adult. The two arthrobranchs of the chela are attached to a space between the pleuron and the coxopodite, *ar-br* (2); in the case of the second and third pereiopods the pleurobranch is attached to a circular opening in the pleuron (*pl-br*, Fig. 80.)

On the second maxillipede (Fig. 64) the gill and epipodite are attached to the first joint of the protopodite. They both rise from the same stem. The gill is a podobranch, and is yet unsegmented. The second gill, viz. the arthrobranch, which is found attached to this appendage in the adult was, if present, not noticed.

On the third maxillipede (Fig. 86) three gills are found in this stage, none of which are segmented. Two are arthrobranchs; they are the gills present in the Zoëa stages. There is also a small gill attached to the second protopodite joint close to the origin of the epipodite; it and the epipodite are probably developed from the long epipodite process seen in the Zoëa.

1. The podobranch of the second maxillipede (*br*, Fig. 71) shows some segmentation in its proximal part. A second plain gill (*br ?*) was made out in one case. The gills are very liable to be knocked off in dissection, and unless the maxillipedes are separated from one another the relations of the parts are not satisfactorily made out.

On the third maxillipede (Fig. 88) only one of the gills is divided into lobes—viz., the larger arthrobranch. The other arthrobranch and the little podobranch have still the smooth outline.

In my paper on the larval stages of *Crangon vulgaris* it was stated, with reference to the gills of the pereiopods, that starting from the podobranch condition they passed through an arthrobranch (non-functional) stage (V.) and that in the Megalops (VI. stage) they appear as functional gills (pleurobranchs) for the first time. Re-examination of these stages has shown that the interpretation of the developing gill in the V. stage as an arthrobranch is wrong. In that stage it is a pleurobranch.

The description given above of the epipodites and gills shows a close similarity between them in their origin and development. This is especially the case in the second and third maxillipedes, where a podobranch and an epipodite are apparently derived from the one bud.

The development of the epipodite of the first maxillipede is included in the description of that appendage, p. 148.

The branchia formula of the adult *Carcinus mœnas* is as follows:—

		Podobranchiæ.	Arthrobranchiæ	Pleurobranchiæ.
First Maxillipede, -	Epipodite	...	...	...
Second Maxillipede, -	Epipodite	1	1	...
Third Maxillipede, -	Epipodite	1	2	...
First Pereiopod (chela),	...	...	2	...
Second Pereiopod, -	...	...	...	1
Third Pereiopod, -	...	...	...	1

ABDOMEN, ab, TELSON, T, PLEOPODS, pl, Plates xi. and xii.

I. ABDOMEN (Figs. 118 and 131). The abdomen consists in the I. Zoëa of five joints and the telson. On the hind lateral edge of the first joint there is a little tubercle, from the middle of the second joint a conical process projects on either side. These processes have probably a mechanical function, since in certain positions of the abdomen they will abut on the hind border of the carapace. They will tend to limit the movement of the abdomen. The hind lateral border of each of the second and fifth segments projects backwards over the beginning of the succeeding joint, and it is minutely notched. On the dorsal hind edge of each of these segments there is a pair of short plain hairs. The integument of each joint is a cylinder.

PLEOPODS. The pleopods are found in this stage as long, somewhat oval bodies composed of large rounded cells; they are situated on the under-surface of the abdominal segments (*pl*, Figs. 118 and 131). These bodies are seen on all the five abdominal joints. On the first joint the body is hemispherical (Fig. 131). Although in structure resembling the rudimentary pleopods in the other joints, it does not give rise to a pleopod. Its ultimate condition was not determined.

The pleopod buds in the I. Zoëa are referred to by Spence Bate as follows:—"Close observation will detect the germs of the future *pleopoda*, upon one or two [abdominal segments], situated laterally and inferiorly."*

TELSON. The telson (Figs. 122 and 118) is in the adult the shield of the anus; in the Zoëa it, in addition to protecting the end of the gut, performs other functions. It is of the form usually found in Brachyurus Zoëa. It is deeply forked: each leg curves gently backwards, and tapers to a delicate point. On the dorsal surface of each leg there are three long teeth, of which the proximal is the smallest, the distal the largest, and the median in position, intermediate in size between the two others. The teeth are smooth On the inside of the furca, arranged on either side of the anal angle, are three stout spines which are elaborately serrated. Three different sets of serrations may be made out on each side of the spine (Fig. 120). The proximal third is provided with large teeth, the middle third with smaller teeth, and the distal third is lined to within a short distance of the sharp tip with minute serrations. The inmost spine of each group has also on the inner side three long cilia; sometimes a cilium is found on its outer side. The serrations on the two sides of the spines were not found to be in focus at the same time; it is therefore probable that

* *Op. cit.*

they are not exactly opposite one another. The telson exemplifies Mayer's typical number of spines—14.

The anus opens on the ventral surface of the telson (*an*, Fig. 157). The end of the gut issues through a round aperture (*op*) in the integument.

II. Abdomen, Pleopods (Fig. 124). The only noticeable feature of the abdomen in this stage is the larger size of the rudiments of the pleopods (*pl*). They are still single.

Telson (Fig. 119). The telson is rather longer and slightly narrower in proportion. On each leg of the furca one tooth only was made out.

III. Abdomen (Fig. 117). The joints of the abdomen retain the characters of the I. Zoëa. Another joint has, however, been added to the abdomen by the segmenting off of the proximal part of the telson, which now forms the sixth abdominal joint (*6*, Fig. 121).

Pleopods (*ib*). The pleopods now project from the hind ventral part of the joint, not apparently through the integument, but issuing between the hind border of the one segment and the beginning of the next. They are paired, and are little conical protuberances which in some cases show a faint line of segmentation off from the abdominal joint. The pleopod of the new or sixth segment does not project externally. The projecting pleopod buds belong to the second, third, fourth, and fifth segments.

Telson (Fig. 121). The telson is much shorter comparatively than in the previous stage, owing to the separation just in front of the anus of the last abdominal joint, otherwise it has not changed from II. Zoëa. Two small hairs were, however, seen on each furcal leg. The anus opens on the telson.

IV. Abdomen (Fig. 129). The backward-directed portions of the lateral integument of certain of the joints is more pointed than rounded.

Pleopods (*ib*). The four pairs of pleopods of the last stage are now long spatulate processes. The pleopods of the sixth abdominal segment appear as small processes (*ib*), and 5 *pl*, Fig. 137. They are more widely separated from one another than are the individuals of the other pairs.

Telson (Fig. 137). The tooth on the furcal leg is reduced to very small proportions. The serrated spines on either side of the furcal angle have remained unchanged during the Zoëa stages.

Megalops. The Abdomen (Figs. 138 and 143) has approached nearly to the adult form. It remains extended (Fig. 152), however, and is never tucked in under the thorax. A few short plain hairs are found on its dorsal surface; a pair of these is found on the dorsum of each segment except the first and sixth, a pair is situated on the hind inferior corner, and a varying number along the hind dorsal edge of each segment.

The Telson (Figs. 143, 127, *a* and *b*) is rounded, with its hind border a little flattened. On its dorsal surface there is a pair of short hairs. On the ventral surface the anus opens.

The Pleopods (Fig. 138) are five pairs, attached to the second, third, fourth, fifth, and sixth segments of the abdomen. The first four pairs are similar to one another; they are biramous, the exopodite being large and spatulate in shape, the endopodite a short oval process. The fifth pair of pleopods, which arises from the hind ventral region of the sixth segment, are 1-branched and very much smaller than the preceding pleopods (Fig. 127, *a*).

The pleopods are the swimming organs of the Megalops, and each exopodite of the first four, and the single-branched fifth, are provided

with a fringe of plumose setæ. These resemble the setæ with which the exopodites of the maxillipedes of the Zoëa are supplied.

The first—fourth pleopods are formed of a single protopodite joint (Fig. 130), from which rise the paddle-like exopodite, *ex*, and the short oval endopodite, *en ib.* The pleopods differ in size. Of the first four, the first is the largest, the fourth is the smallest, and the second and third are intermediate in size.

From the margin of the distal half or two-thirds of the exopodite project the plumose setæ, which, shortest proximally, increase in length the more distal their origin (Figs. 142, 132, 130, and 141). There are usually 11 setæ on the exopodite of the first and fourth pair of pleopods, and 12 (or 13) on the second and third pleopods. In each case there are two terminal setæ, and four on the external margin. In the first and fourth pleopods there are five on the internal margin, and in the second and third pleopods six setæ on that edge. But the number on the internal edge varies. I have not noticed any variation in the number of the outer series, though it probably exists. No number greater than seven was found on the inner margin, making 13 setæ on the exopodite. In the case of two second pairs of pleopods, in each the exopodite on one side had 13 setæ, and on the other side the exopodites had 12 and 11 respectively.

The endopodite bears on the internal face of its extremity three or four curved hooks (Figs. 134 and 136). By means of these the endopodites of a pair of pleopods are locked to one another, in this way stiffening the pair into a single double-paddle, and thereby increasing its efficiency.

The endopodite is not completely segmented off from the protopodite (Fig. 134). It is a rigid process of the latter. At its junction with the basal joint there is a large bulbous thickening of the integument, which serves to strengthen and give elasticity and rigidity to the part. The hooks, too, arise from a thickened bed of chitin.

The fifth pleopod is a single-branched appendage; it consists of two joints (Fig. 127, *a*). The first joint has a broad base. The second joint bears five plumose setæ, two terminal, two on the outer edge, and one on the inner edge close to the apex of the joint. The respective lengths of the setæ are shown in the drawing. This pleopod lies beneath the telson, and in a dorsal view of the abdomen is hid by it.

1. The Abdomen (Figs. 145 and 151) now in general form resembles the adult condition. In the adult the shape of the abdomen is a sexual character, that of the female being broad, that of the male narrow. In this, the first young stage, we have an intermediate condition, a non-sexual state. It is narrower in comparison than the abdomen of the female and broader than that of the male.

The abdomen no longer functions as a swimming organ; it is tucked up against the thorax, to which it adheres closely, lateral movement being prevented by the tubercles (*t*, Fig. 164) on the eleventh somite (*i.e.* that to which the second pereiopods belong). In the adult the tubercles fit into depressions on the sixth abdominal segment. They prevent lateral movement of the abdomen, and their function in this stage is probably a similar one. They are much larger in the adult male than in the female crab.

The abdomen is profusely adorned over its dorsal surface with ciliated hairs (Fig. 128). The arrangement and number of these is shown in Fig. 151. Over the telson and the lateral parts of the dorsum of each segment except the first, there are considerable numbers of the minute "needle-point" cilia.

The Telson (Figs. 151 and 158) now functions simply as the shield of the anus. It has not yet adopted the adult form; in the latter the telson is of a triangular form, with a more or less pointed apex. The telson may be raised from the thorax independently of the abdomen. In this stage the dorsal surface is provided with ciliated hairs, and it is also covered with the minute surface cilia.

The Pleopods (Figs. 145 and 156) have degenerated in this stage. In absolute measurement, although the crab itself has increased greatly in size, they are smaller than the pleopods of the Megalops. The abdomen now being closely fitted into the hollowed surface of the thorax, they can no longer function as swimming organs, and they have not yet taken on their adult sexual form. They are devoid of setæ and hooks (Fig. 156); one or two minute hairs are seen on the exopodites. The fact that the endopodite is merely a process of the basal joint, not a separate branch, is well seen in this stage.

The fifth pleopod (Fig. 156) is a small shrunken process, in which the separation into two joints is not always visible.

2. In the second young stage the pleopods are similar to those of the first young stage, but smaller.

External Sexual Characters.

In the second young stage the external sexual characters have not appeared. I have not followed the development of the pleopods farther by successive stages, but the swimmerets of the female and the penes of the male appear very soon after the second stage. The breadth of carapace in the latter is about 2·5 mm.

In a crab measuring $5\frac{1}{4}$ mm. across the greatest breadth of the carapace, the female sexual characters were found. The swimmerets were present in their adult form, consisting of a 1-jointed exopodite and a 2-jointed endopodite (Fig. 165). Neither branch bore any hairs at all. The position of the vulvæ, viz. in the twelfth somite, that to which the third pereiopod belongs, was indicated by little clear depressions, but there were no openings. In a female 9 mm. across, the vulvæ were small clear circles (apparently not yet perforated); the swimmerets resembled those of the adult female, but very few hairs were present on each branch.

In a crab measuring $5\frac{1}{2}$ mm. across (greatest breadth of carapace), the male sexual characters were found. The two penes were present, the anterior (1 *p*) and the posterior (2 *p*), Fig. 155. No trace of vulvæ was seen in this specimen. The tubercles on the eleventh somite were prominent. A small clear area, not very distinctly made out, was noticed on the coxopodite of the fifth pereiopod, in the situation occupied in the adult by the external opening of the vas deferens.

No distinction in the breadth of the abdomen which separates the adult sexes was yet apparent.

The Eye, o,

I. (Figs. 159, 161, 163). The eye of the I. Zoëa resembles that of *Crangon vulgaris* * in that its cornea is a specialised portion of the carapace. Drawings of the moulted carapace of the first Zoëa are shown; oblique side view Fig. 161, and ventral view 163. The cornea is labelled, *o*.

The median eye was not made out, although an irregular black area was seen in the region where the median eye was to be sought for.

* *Op. cit.*

II.-IV. In the remaining Zoëa stages the eyes are quite free from the carapace, and have very short stalks. Fig. 157 represents the eye of the IV. Zoëa.

Megalops (Figs. 152 and 153). The eyes have very long thick stalks, through which they are projected laterally well out beyond the edge of the orbit.

In succeeding stages, development, so far as concerns the eye, consists in its gradual reduction in size, and in its shifting from a lateral to an antero-posterior position.

1 (Fig. 167). The eyes are much reduced in comparative size.

2, 3, and 4 (Figs. 173, 170, and 171). The eyes are now bending forward. The eye is, however, too large to be contained within the orbit.

Crab 5·5 mm. across (Fig. 172). The eye can now lie down in the orbit.

Adult (Fig. 168). The narrowing of the frontal region has brought the eyes closer together. The bend in the eye stalk was first noticed in the third and fourth young stages. The eyes are now very small.

The eye has simply taken part in the general alteration in the anterior half of the carapace.

Carapace, Plates xii. and xiii.

I., II., III. (Figs. 159, 148, and 147). The carapace of the Zoëa is, except in possessing the dorsal spine, similar to that of a Macrouran. It is prolonged in front into the long, almost straight, rostral spine; and from the middle of the dorsum, immediately over the heart, rises the curved dorsal spine. In these stages no hairs were found on the edge of the carapace.

IV. (Fig. 146). The carapace is as in previous stages, except that there is now a row of small ciliated hairs attached on the inner side of the margin.

Megalops (Fig. 153).—The dorsal spine has disappeared, and the rostral spine is reduced to small dimensions. Over the surface of the carapace, and round the hind lateral border, there are distributed small plain hairs. The hairs are symmetrically arranged as shown in the sketch. The frontal region is broad, and the eyes are in consequence widely separate. It has no lateral teeth.

The carapace is longer than it is broad.

1. (Fig. 166). The four lateral teeth appear in this stage, and of these, two are more prominent than the others. The corner of the orbit might be regarded as a tooth, but it is not properly so designated. The general form of the carapace is nearly circular. It is just about as broad as it is long. The broad frontal region is noteworthy. The rostral spine has disappeared, and the frontal area shows a trilobed waving.

The carapace is covered on its dorsum with the minute "needle-point" cilia, and it is supplied with ciliated and plain hairs. The ciliated hairs which are located on or near the edges are similar to the ciliated hairs found on the dorsum of the abdomen (Fig. 128). The plain hairs are scattered over the dorsal surface of the carapace. The minute cilia are very thickly distributed: in the drawing their size is exaggerated.

"From the first to the sixth young stage the carapace assumes its normal shape by a gradual increase in its width compared to its length. With each successive moult the lateral toothed margins are pushed more forward and the teeth become more prominent." (Brook.*)

* *Op. cit.*

Cp. Cunningham's* description of the early young stages of *Cancer pagurus*. In this form also the carapace of the early crab stages is longer than broad.

2. (Fig. 173). The carapace is now approaching the adult shape. It is slightly broader than long. The shortening of the carapace results in pushing out the toothed area on either side.

The broad frontal region still persists.

The minute cilia are still present on the carapace.

3. (Fig. 170). The lateral teeth are a little farther out. The hindmost tooth now projects considerably beyond the level of the corner of the orbit. The frontal region is still very broad, and it shows the trilobed waving.

The lateral teeth are gradually becoming of one size.

The "needle-point" cilia are seen on the carapace.

The carapace is considerably broader than long.

4. (Fig. 171). The lateral toothed border is now distinctly farther forward than in the previous stage. The frontal region remains practically unchanged.

The "needle-point" cilia are still present.

In the cast measuring 4·25 mm. of Waddington's series, No. 1, p. 165, the "needle-point" cilia were not made out, but little tubercles were seen scattered over the dorsum of the carapace.

Crab 5·5 mm. across (Fig. 172). In this specimen not much change in shape is noticed. The lateral teeth are now nearly all of one size.

The minute cilia were not made out in this specimen.

Adult.—The change from the last crab to the adult condition (Fig. 168, male, *natural size*) is a gradual lessening of the breadth of the frontal region, and a pushing forward of the toothed border into an antero-lateral position. The reduction in breadth of the frontal region is accompanied by the emphasising of the trilobed waving into three distinct lobes; the median projects a little in front of the other two.

The tri-lobed frontal region develops by the gradual pushing out of the central lobe (rostrum). In the series of casts of No. 1 of Waddington's collection (p. 165) the change in the frontal region is well shown. In the cast measuring 7·5 mm. across, the rostrum is seen to project very slightly in front of the broad frontal region. The three lobes are not distinct in this series until a size of 18 mm. is reached. In this stage the three lobes are well marked, but the lateral lobes are not so sharply cut off from the edge of the orbit as in the adult stages.

Thorax.

In the I. Zoëa (Fig. 85) the thorax appears in two distinct parts—the anterior narrow portion which bears the first and second maxillipedes, and the posterior part bearing the buds of the third maxillipede and the pereiopods. Its sternal surface is oval in shape, and it may be separated off, from the buds surrounding it, as an oval plate. In this stage it forms a comparatively small part of the sternum of the cephalothorax.

During the remaining Zoëa stages it increases in size with the growth of the buds of the appendages, but even in the IV. Zoëa it does not yet bear its true proportion to the rest of the body: segmentation may be traced in it (Fig. 150).

In the Megalops (Fig. 149) the part of the thorax that has developed during the Zoëa period, now forms the greater part of the sternum of the cephalothorax. Although the abdomen is not tucked up under the thorax, the latter is depressed posteriorly along the median line.

* Cunningham, "On the early post-larval stages of the common crab (*Cancer pagurus*), and on the affinity of that species with *Atelecyclus heterodon*." *Proc. Zool. Socy. Lond.*, Mar. 1898. 1 pl.

In the first young stage (Figs. 164 and 169) the two tubercles are present. The sternum is covered with the minute "needle-point" cilia, except over the surfaces covered by the abdomen.

Sexual characters are not seen. They were made out in crabs measuring $5\frac{1}{4}$ and $5\frac{1}{2}$ mm. across.

Sizes of the Different Stages.

The drawings of all the stages are done on the same scale.

Alongside the enlarged drawings of the I.-IV. Zoëæ and of the Megalops, first and second young stages, outlines are placed representative of the natural size.

In comparing the Zoëa stages, the distance between the tips of the rostral and dorsal spines was taken as the standard of measurement.

Stage.	Number of Specimens.	Distance between the Tips of Rostral and Dorsal Spines. *Mm.*
I.	2	1·3 : 1·5.
II.	1	2.
III.	2	2·3 : 2·4.
IV.	1	3.

Megalops and succeeding Stages.

For the Megalops and succeeding stages two measurements were taken of the carapace—(1) The greatest breadth. In all, except the Megalops, this is at a fixed point, viz. behind the hindmost lateral teeth. (2) Length of the carapace, *i.e.* the distance between the tip of the rostrum and middle of the hind border of the carapace.

Stage.	Number of Specimens.	Greatest Breadth. *Mm.*	Greatest Length. *Mm.*
Megalops .	1	1·15	1·5
1 . . .	2	1·6 : 1·75	1·7 : 1·7
2 . . .	1	2·4	2·2
3 . . .	1	3·4	3·1
3A . .	1	3·1	...
4 . . .	1	3·9	3·3
4A . .	1	4·0	...

With the exception of 3A the stage of each of these young crabs was known, since they were reared in the Laboratory from the Megalops stage. They are not, however, successive casts of one individual.

The crab 3A was found on the beach, and from its size it is probably a specimen of the third stage. It cast in confinement, and the resulting form appears in the Table as 4A.

Food of Megalops.

In the fæces of a Megalops there was a large quantity of diatoms.

Rate of Growth of *Carcinus mœnas.*

In the growth of the crab a considerable amount of variation occurs. This is due to the fact that increase in size only occurs after a moult, and the amount of the increase varies not only with the individual, but also in the same specimen in different moults. It is, however, possible with a fair amount of certainty to separate the crabs into year groups, as will be shown later, if attention be given in the case of small crabs to the month in which they are captured.

In 1884 Brook published a series of observations on the rate of growth of *Carcinus*. He confined a number of specimens until they passed through a series of moults. He at that time wrote—"It would appear impossible to judge either the age of any particular specimen, or the number of ecdyses which it had passed through, from a casual observation of it on the sea coast, and even in confinement a number of ecdyses must be passed through before any reliable information is obtained." He was of the opinion that two of his specimens which he reared from the Megalops stage, A and B, would have reached the breadth of 35 and 56 mm. respectively when two years old.

For several years Mr. H. J. Waddington, Bournemouth, has devoted attention to the rearing of this form. He has succeeded in obtaining a very complete and valuable series of casts of various specimens. The results of his work he has courteously communicated to me, and with his permission they are incorporated in the present paper.

They refer to 11 individuals which were kept in confinement for periods varying from 7 to 34 months. The particulars, consisting of the size* of each moult-stage and its date, are given in Table I. The first date and size refer in each case to the size and date of capture. For three Waddington series, viz. Nos. 8, 9, and 10, Table I., I am indebted to Meek's paper on the "Rate of Growth of the Crab."† Alongside the measurement of each cast the ratio of increase is given, and the interval that elapsed between each two moults is appended.

I have also arranged the data regarding five of Brook's specimens in a like manner in Table II.

* The size consists in the *Greatest Breadth* of the Carapace.

† *Northumberland Sea Fisheries Committee. Report on the Scientific Investigations* for the year 1902. Newcastle-upon-Tyne, 1903, p. 58.

TABLE I.

THE MOULTING OF *Carcinus mœnas*—Waddington's Series.

1. ♂				2. ♂				3.				4. ♀				5. ♂			
Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.
1899.				1899.				1900.				1900.				1900.			
18 Aug.	·9M	...	...	Aug.	4·75	...	...	19 June	6·25	...	...	19 June	2·5	...	...	19 June	2·5	...	...
21 ,,	1·15	1/3·6	...	4 Sept.	5·75	1/4·7	...	21 ,,	8·25	1/3·1	...	28 ,,	3	1/5	...	21 ,,	3	1/5	...
3 Sept.	1·6	1/2·3	13	1 Oct.	7	1/4·6	27	15 July	9·75	1/5·5	24	12 July	3·75	1/4	14	6 July	3·5	1/6	15
16 ,,	1·85	1/6	13	19 ,,	9·25	1/3·1	18	25 Aug.	12·5	1/3·6	41	22 Aug.	5	1/3	41	1 Aug.	4	1/7	26
30 ,,	2·5	1/2·8	14	6 Nov.	12	1/3·3	18	29 Oct.	15·75	1/3·8	65	15 Sept.	6	1/5	24	1 Sept.	4·75	1/5·3	31
12 Oct.	3·25	1/3·3	12	13 Dec.	16	1/3	37	1901. 4 Jan.	21	1/3	67	28 Oct.	7·5	1/4	43	4 Nov.	6·25	1/3	64
27 ,,	4·25	1/3·2	15	1900. 1 Jan.	20	1/4	19	23 April	24·5	1/6	109	24 Dec.	9·5	1/3·7	57	27 Dec.	7·5	1/5	53
10 Nov.	5·75	1/2·8	14	3 Mar.	died.			11 June	30·75	1/3·9	49	1901. 7 Mar.	12·75	1/2·9	73	1901. 1 April	8	1/15	95
29 ,,	7·5	1/3·2	19					29 July	36	1/5·8	48	1 June	15·5	1/4·6	86	29 May	10	1/4	58
28 Dec.	10	1/3	29					6 Sept.	died.			3 July	19·75	1/3·6	32	27 June	12·5	1/4	29
1900. 1 Feb.	13·5	1/2·5	35									2 Aug.	25·5	1/5	30	20 July	15·5	1/4	23
7 Mar.	18	1/5·4	34									17 Sept.	32	1/3·9	46	24 Aug.	19	1/3·8	35
25 April	died.											4 Nov.	39	1/4·5	48	23 Sept.	24·5	1/3·4	30
												1902. 1 May	48	1/4·3	178	24 Oct.	33	1/2·8	31
												5 Oct.	55	1/6·8	157	11 Dec.	41	1/4	48
												1903. 1 May	,,	...	(207)	1902. 25 Mar.	53	1/3·4	104
																28 Aug.	59·5	1/5	156
																1903. 1 May	,,	...	(245)

TABLE I.—*continued.*

THE MOULTING OF *Carcinus mœnas*—Waddington's Series.

6. ♀				7.				8.				9.				10.			
Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.
1900.				1899.				1896.				1896.				1897.			
19 June -	6·5	...	...	...	16·5	...	...	19 Aug. -	3	...	...	12 Sept. -	12·5	...	...	23 Feb. -	9	...	...
4 July -	8·25	1/3·7	...	7 July -	19·25	$\frac{1}{6}$	...	31 ,, -	3·5	$\frac{1}{6}$	...	25 Oct. -	16·5	1/3·1	...	8 April -	12	$\frac{1}{3}$	...
13 Aug. -	9·5	1/6·6	40	6 Aug. -	24	1/4·5	30	14 Oct. -	4	$\frac{1}{7}$	44	1897. 14 Jan. -	21	1/3·7	81	30 May -	14	$\frac{1}{6}$	52
21 Sept. -	12	1/3·8	39	9 Sept. -	30	$\frac{1}{4}$	34	1897. 8 Jan. -	5·5	1/2·7	86	11 April -	29·5	1/2·5	87	10 July -	18·5	1/3·1	41
29 Oct. -	15	$\frac{1}{4}$	38	30 Oct. -	37	1/4·2	51	4 April -	8	1/2·2	86	30 July -	37	1/3·9	110	31 Aug. -	25	1/2·8	52
1901. 9 Jan. -	19	1/3·7	72	1900. 2 Jan. -	46·5	1/3·9	64	2 May -	10	$\frac{1}{4}$	28	7 Oct. -	46·5	1/3·9	69	19 Oct. -	33	1/3·1	49
27 May -	23·75	$\frac{1}{4}$	138	15 April -	62	$\frac{1}{8}$	103	6 June -	13	1/3·3	35	1898. 17 May -	58·5	1/3·9	222	1898. 7 June -	42·5	1/3·5	231
3 July -	29	1/4·5	37	1902. Jan. -	,,	...	nearly 2 yrs.	12 July -	17	1/3·3	36								
3 Sept. -	36	$\frac{1}{4}$	62	April -	died.			15 Aug. -	22	1/3·4	34								
12 Nov. -	48·5	1/2·8	70					2 Oct. -	28	1/3·7	48								
1902. 8 Sept. -	55	1/7·4	292																
1903. 1 May -	,,	...	234																

TABLE I.—*continued.*

THE MOULTING OF *Carcinus mœnas*—Waddington's Series.

No. 11. ♂

Date.	Size—Mm.	Ratio of Increase.	Interval—Days.	Date.	Size—Mm.	Ratio of Increase.	Interval—Days.
1901.				1901.			
14 May -	...	...	...	14 Oct. -	9·5	1/2·1	25
17 ,, -	...	...	...	12 Nov. -	12·5	1/3·1	29
29 ,, -	2	...	12	13 Dec. -	16·5	1/3·1	31
13 June -	3	$\frac{1}{2}$	15	1902. 28 Feb. -	22	$\frac{1}{3}$	77
26 ,, -	4	$\frac{1}{3}$	13	16 April -	28·5	1/3·3	47
10 July -	4·5	$\frac{1}{8}$	14	29 June -	35·5	$\frac{1}{4}$	74
3 Aug. -	5	$\frac{1}{5}$	24	17 Oct. -	43·5	1/4·4	110
1 Sept. -	6	$\frac{1}{5}$	29	1903. 21 Mar. -	52	1/5·1	155
19 ,, -	6·5	$\frac{1}{12}$	18	April -	,,		

TABLE

TABLE II.

THE MOULTING OF *Carcinus mænas*—Brook's Series.

A.				B.				P. ♀				N. ♂				Y. ♂			
Date.	Size—Mm.	Ratio of Increase.	Interval Days.	Date.	Size—Mm.	Ratio of Increase.	Interval —Days.	Date.	Size—Mm.	Ratio of Increase.	Interval —Days.	Date.	Size—Mm.	Ratio of Increase.	Interval —Days.	Date.	Size—Mm.	Ratio of Increase.	Interval —Days.
1883.				1883.				1882.				1882.				1882.			
25 Aug. -	·9M	...	...	25 Aug. -	·9M	...	...	3 July -	6	...	...	18 July -	15·5	...	...	...	14·5	...	...
26 ,, -	1·5	3/3	...	28 ,, -	1·3	5/5	...	29 ,, -	7·5	1/4	...	17 Aug. -	18·5	1/5	...	4 Sept. -	20	1/2·6	...
5 Sept. -	2·3	1/1·8	10	15 Sept. -	2·3	1/2·2	18	16 Aug. -	10	1/3	18	2 Oct. -	23	1/4	16	5 Oct. -	29	1/2·2	31
20 ,, -	3	1/3·2	15	11 Oct. -	3·1	1/2·8	26	10 Sept. -	14	1/2·5	24	1883. 5 Feb. -	29	1/3·8	126	28 Nov. -	39	1/2·9	54
16 Oct. -	3·7	1/4·2	26	1 Nov. -	4·2	1/2·8	21	1883. 1 Feb. -	19·5	1/2·5	144	21 May -	37	1/3·6	105	1883. 27 Feb. -	51	1/3·2	92
14 Dec. -	4·5	1/4·6	59	1884. 29 Jan. -	5·2	1/4·2	89	16 May -	26·5	1/2·6	104	21 Aug. -	45	1/4·6	92	15 June -	56	1/15	108
1884. 8 Mar. -	5·1	1/7·5	84	23 April -	6·7	1/3·4	84												
				6 June -	8·9	1/3	44												
				9 July -	11·6	1/3·3	33												
				2 Aug. -	15·5	1/2·9	24												

An examination of the two Tables shows that, as Brook pointed out, moulting takes place more frequently in the summer months than in the winter. Casting is not, however, confined to the warm months, but occurs in every month of the year.

That the protection afforded the crabs in confinement may have stimulated growth is possible; and while their frequent casting during the first year may be due in some measure to the regular and certain provision of food, still it has been assumed that the growth indicated by the above specimens is not greater than that of the more favoured individuals in the free state.

In order to compare the frequency of moulting in different individuals, Waddington's and Brook's specimens have been set out in Table III. In it the month in which each moult took place and the resulting size of the crab are shown. At the top of each series the authority for it is indicated by means of a letter and number. B refers to Brook, and the number or letter accompanying it relates to the form thus designated in his paper in the *Annals and Magazine of Natural History* (V.) 14, 1884, p. 202 *et seq.* The others refer to the individuals particularised in Table I.

TABLE III.

Month.	I. Megalops—March (?)						II. M.—April (?)		III. M.—May.				IV. M.—June (?)					V. M.—August (?)					
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
	B.	W.	W.	B.	W.	B.	W.	W.	B.	W.	W.	W.	B.	B.	B.	W.	W.	B.	B.	W.	B.	B.	B.
	8.	*3.*	*6,* ♀	*P,* ♀	*9.*	*a* ♂	*11* ♂	*2.*	*B,* ♀	*4,* ♀	*5,* ♂	*10.*	*D,* ♀	*C,* ♂	*M* ♂	*8.*	*7.*	*Z.*	*A.*	*1,* ♂	*B.*	*Y,* ♂	*N* ♂
April	2·6																						
May	3·3						–																
							2																
June	6·25	6·25	6·5				3			2·5	2·5												
	8·25						4			3	3												
July		9·75	8·25	6			4·5			3·75	3·5												
				7·5																			
Aug.		12·5	9·5	10			5	4·75		5	4					3			·9*	·9*	·9*		
																3·5		2·3	1·5	1·15	1·6		
Sept.	15·75		12	14	12·5	12	6			6	4·75							3	2·3	1·6			
							6·5	5·75										4·1	3	1·85	2·3		
																				2·5			
Oct.			15		16·5	15	9·5	7		7·5						4			3·7	3·25	3·1		
								9·25												4·25			
Nov.							12·5	12			6·25									5·75	4·2		
																				7·5			
Dec.							16·5	16		9·5	7·5								4·5	10			
Jan.		21	19		21			20								5·5					5·2		
Feb.				19·5		20·5	22					9								13·5			
Mar.										12·75									5·1	18			
April	24·5				29·5		28·5				8	12	16	16		8					6·7		
May			23·75	26·5							10	14			13	10							
June	30·75						35·5		26	15·5	12·5		22	23	17·5	13	16·5				8 9		
July	36		29		37				35	19·75	15·5	18·5	28	30·5	23	17	19·25				11·6		15·5
Aug.										25·5	19	25			31	22	24				15·5	14·5	18·5
Sept.			36							32	24·5						30					20	
Oct.					46·5		43·5				33	33				28	37					29	23
Nov.			48·5							39												39	
Dec.											41												
Jan.																	46·5						
Feb.																						51	29
Mar.							52				53												
April																	62						
May					58·5				42	48													37
June												42·5											
July																						56	
Aug.											59·5												45
Sept.			55																				
Oct.										55													
Nov.																							
Dec.																							

Megalops.

Among specimens less than a year old, found at any date, a large amount of variation in size will be found. This is in part due to the fact that the young of *Carcinus* are hatched during a period of several months. It therefore happens that in the autumn some have gained a considerable size, *e.g.* $\frac{1}{2}$ inch, while others may not exceed $\frac{1}{5}$ inch. The hatching period, as stated above, lasts from March till at least the end of July.

The Megalops stage has been selected as a convenient period from which to calculate the age of the crab. Three of the crabs, viz. Nos. 19, 20, and 21, Table III., were reared from the Megalops. No. 7 was probably in the first young stage when it was found, and Nos. 10 and 11 (2·5 mm.) have been regarded as belonging to the second young stage, *i.e.* one cast has intervened between it and the Megalops. Nos. 2, 3, and 4 had probably already passed through six moults when captured. They measured respectively 6, 6·25, and 6·5 mm. I have assumed that the three last had been in the Megalops stage in March, and that No. 7 was at a similar stage in April, and Nos. 10, and 11 in May. No. 16 (3 mm.) is in the third stage, and is supposed to have been a Megalops in June.

In this Table the attempt has been made to arrange together crabs that were probably hatched out in the same month. For this purpose five different groups have been recognised among the crabs that compose the series. In the case of the crabs which were very small when captured the month in which they were in the Megalops stage may be fixed for all practical purposes with certainty. These crabs of known age then form the standard by which the ages of larger crabs are judged.

In the first group are included those crabs which were in the Megalops stage very probably in March. Group II. contains certain crabs which were in the Megalops in April, and Group III., in May. The supposed June crabs appear in IV., while in V. are included four, the ages of which are known.

Crabs Nos. 5 and 6 are admitted into the first group; they measured 12·5 and 12 mm. respectively in September, and are evidently the young of the hatching season just ended. The age of these crabs may then with reason be estimated on the date of capture to be only a few months.

The number of casts that the young crab passed through in its first year varied. Thus No. 21 cast 8 times in its first twelve months; No. 20, however, cast 11 times in its first seven months; while No. 19 cast only 6 times in the first seven months. No. 7 had moulted 13 times at least in its first year, while Nos. 10 and 11 had passed through 9 (?10) ecdyses in the same time. Regarding Nos. 2, 3, and 4 as being when captured in their sixth young stage, we have at the end of the year (end of February) 11, 11, and 10 casts respectively.

The five groups are divided by horizontal lines into 1-year periods, the year being calculated from the Megalops stage.

Great variation is found in the size of the crab when one year old No. 21 at the end of the first twelve months measured 11·6 mm.; No. 7 measured 22 mm., and Nos. 10 and 11, 8 and 12·75 mm. respectively. Assuming that Nos. 2, 3, and 4 were in the Megalops stage in March, which is the earliest in the year that we are justified from our knowledge of the hatching season in fixing, they cannot at the end of February be more than one year old. They then measured respectively 19, 19·5, and 21 mm. in breadth. The most marked difference is, however, seen in Nos. 19, 20, and 21. The first and last are Brook's specimens, No. 20 is one of Waddington's series. The latter in seven months reached a breadth of 18 mm., while the former were at the end of the same period 5·1 and 5·2 mm. respectively. The crabs were not exposed to identical condi-

tions, and this variation shows how much the growth of the crab may be affected by its environment. It is, moreover, to be noted that in the case of No. 20 the rate of increase at each moult was, to begin with, very small, and so it happened that No. 19 gained a larger size in four months than Waddington's (No. 20) reached in five months.

The size at the end of the first twelve months is obtained from crabs Nos. 7, 10, 11, and 21, the ages of which are known exactly. They measured respectively 22 : 12·75 : 8 : 11·6; these figures give an average of 13·5 mm. In the four sizes given we have probably the upper and lower limits of size after one year's growth, viz. 22 and 8 mm. The crab will not, it is believed, grow to a greater size than 22 mm. in the first year, and no crab is probably less than 8 mm. when it is a year old.

Crabs Nos. 12, 13, 14, 15, and 23 are about one year old, while Nos. 9, 17, and 22 are in their second year. Crab No. 23 appears to have been in the Megalops stage later in the year than August, probably in September.

From the size of the crab when captured, we can tell, by considering the month when it was found, whether the crab is or is not a year old. The size alone without the date is in the case of the small crabs of little value. For example, a crab that measured 13 mm. in May would probably be over a year old, whereas one of that size captured in September would be six or seven months old.

The crabs then have been arranged in Table III. according to the age which their size and date of capture seem to indicate. The crabs of known age are taken as a standard of comparison.

Column V. contains one series about which there might be some doubt as to its being properly included there. It is No. 22. In August when captured it measured 14·5 mm.—that is, very little greater than No. 2, which was regarded in August as being only a few months old. The former has, however, been placed in the second year, mainly on account of the large size which it reached (56 mm.) at the end of one year in captivity.

During the second year the casts were still numerous in certain cases; that was especially so in the case of crabs which commenced the second year at a small size. The more frequent casting of the latter then enabled them to overtake the larger specimens. And so at the end of the second year the differences in size between the crabs tend to get eliminated or altered in a different sense, the smaller of the first year becoming the larger at the end of the second year. This is well shown by Nos. 10 and 11. No. 11 commenced the second year at a size of 8 mm., while No. 10 measured 12·75. The former moulted eight times to the latter's five, and at the end of the second year it measured 53, while No. 10 had reached only 39 mm. The different rate of growth in the second year may have been in some measure due to sex; No. 11 was a male and No. 10 a female. A good example is, however, shown by Nos. 7 and 11. They are both males. At the beginning of their second year they measured respectively 22 and 8 mm.: during the second year No. 7 moulted four times, No. 11 eight times, and at the end of the period they had reached 52 and 53 mm. in breadth. The number of moults during the first two years was then 15 to 17. The sizes of the crabs which are known to be two years old are—Male (Nos. 7, 11), 52 and 53 mm.: female (Nos. 3, 10), 48·5 : 39 : and the arrangement of the Table gives the following in cases where the crab was not reared from a very small size:—Male, 56 : 45 (?); female : 35; sex not noted, 33 : 46·5 : 62. The average sizes for those of definitely known age are, at the end of two years—Male, 52·5;

female, 43·7. The inclusion of the other males and females just noted reduces the averages to—Males 51·1 mm., and females 39·3 mm.

Three crabs (Nos. 3, 10, and 11) lived to complete their third year. They measured respectively—Male 59·5, female 55 : 55. The crab No. 17, which was 62 mm. broad in its second year, did not cast again during the succeeding twenty months; it died soon after that interval. 60 mm. may be taken as the size of the three-year-old male and 55 for the three-year-old female.

The conclusions regarding the rate of growth of the crabs under discussion are as follows :—

1 Year,	8–22 mm.	Average	13·5 mm.
2 Years,	♂ 45–56 mm. ♀ 35–48·5 mm.	Average	♂ 51 mm. ♀ 39 mm.
3 Years,	♂ 60 mm. ♀ 55 mm.		

Meek estimates the rate of growth as follows :—

One year, average 9 mm. : two years, average 37 mm. : three years, average 55 mm. : four years, average 69 mm.

The discussion has rested principally on Waddington's series, and of these the specimens which were got at a very early stage are especially valuable. The larger crabs which were introduced into the second year division had, by their subsequent growth, apparently justified the arrangement followed.

The number of specimens under consideration is small, and it is difficult to know how far the conclusion may be legitimately applied directly to the crab in nature. A considerable amount of variation was shown in the growth of the crabs in their first year, and this it may be taken for granted occurs in nature, possibly to as great a degree as in the confined crabs. In the second year there was a tendency to eliminate the differences, a hastening of the development in the backward specimens up to the level of the more forward individuals.

It appears very probable that the results will agree on the whole very closely with the life of the crab in the free state.

Moulting—The Ratio of Increase.

The number of moults through which a crab passes in a year appears fairly constant. Thus during the first year they were 8 to 11 in number; in two years, 14 to 17; and in three years 16–18. That moulting does not depend on the supply of food alone is apparent from the fact that the ratio of increase is so variable, *vide* Tables I. and II. The ratio of increase, that is the actual increase (mm.) at a moult, divided by the previous size of the crab, varies from $\frac{1}{15}$ to $\frac{2}{3}$: it is very often about $\frac{1}{4}$. In the earliest stages the moults follow one another rapidly, sometimes two (*e.g.* Nos. 7, 18, 19) or even three (No. 20) occurring within a month. The rate of growth decreases with age (Meek). The Tables do not show a regular decrease in the ratio, but the decrease in the rate of growth is effected by the less frequent moulting or its cessation altogether.

Early Spawning.

Two females, Nos. 3 and 10, extruded their eggs in winter before the end of their third year. One of them extruded its eggs the previous

winter, *i.e.* before it was two years old. They had been reared from the size of 2·5 and 6 mm. respectively. Neither had during its captivity been in contact with the male crab. The eggs did not become properly attached to the swimmerets: they were all thrown off within a month of extrusion.

Absorption Area on Chela.

A part of the shell of the coxopodite of the chela becomes decalcified at the time of casting, a soft area similar to that found in the lobster at that time, appearing in the crab also. This is regarded by Herrick as an arrangement necessary for permitting the withdrawal of the chela from its shell.

Dr. Hansen, Copenhagen, and Dr. Calman, British Museum, have kindly assisted me with references to literature.

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LIST OF DRAWINGS.

The Drawings were all outlined by means of the *Camera lucida.* The hair and spine arrangement is shown identically as found in the appendages in nearly all the sketches. In Figs. 36, 55, 77 (2 m). 166, 170, and 173 the hairs are not reproduced in identical number nor position.

LETTERS USED.

a.—antennule.
ab.—abdomen.
an.—anus.
A.—antenna.
ap.—pleuron.
b-isch.—basi-ischiopodite.
br.—branchia.
car.—carapace.
carp—carpopodite.
cox.—coxopodite.
cr.—crown (mandible).
dact.—dactylopodite.
e.—cutting edge(mandible).
en.—endopodite.
ep.—epipodite.
ex.—exopodite.
fr.—fracture plane.
g.—gut.
ga.—ganglion.
I.–IV.—1st–4th Zoëa stages.
1 m.—first maxilla.
2 m.—second maxilla.
mer.—meropodite.
mn.—mandible.
mp (1–3).—1st, 2nd, and 3rd maxillipedes.
o.—eye.
per (1–5).—1st–5th pereiopod.
pl.—pleopod.
prop.—propodite.
prot.—protopodite.
st.—sternum.
sw.—swelling, bud of flagellum (A).
t.—tooth.
T.—telson.
th.—thorax.
1–4.—1st–4th young stages.

EXPLANATION OF PLATES.

The magnifications (in diameters) are approximate.

PLATE VII.

Fig. 1. End of first joint of jointed branch of antenna, I. Zoëa.
Fig. 2. Antennule, I. Zoëa; *ga.* ganglion, ... × 220
Fig. 3. Antennule, II. Zoëa, ... × 220
Fig. 4. Antennule and antenna, III. Zoëa, ... × 120
Fig. 5. End of first joint of jointed branch of antenna, III. Zoëa.
Fig. 6. Antenna and antennule, IV. Zoëa, ... × 120

Fig. 7. Antenna of first young stage (1), ... × 48
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Fig. 31. Spine of first maxilla, I. Zoëa.
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Fig. 33. Ventral surface, cephalic region, I. Zoëa, . . . × 100
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Plate VIII.

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Fig. 41. First maxillipede, IV. Zoëa, ... × 57
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Fig. 44. Spine of second maxilla, I. Zoëa.
Fig. 45. Second maxilla, I. Zoëa, ... × 220
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Fig. 58. Protopodite lobes of first maxillipede, first young stage.
Fig. 59. Second maxilla, first young stage, ... × 120
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* The drawings of the pereiopods in nearly every case show only the part of the appendage distal to the fracture plane (*fr.*), viz., that part of the limb which may be thrown off by the crab.

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Plate XII.

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Fig. 147. III. Zoëa, ... × 19
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Fig. 159. I. Zoëa, ... × 19
Fig. 160. Protozoëa, ... × 120
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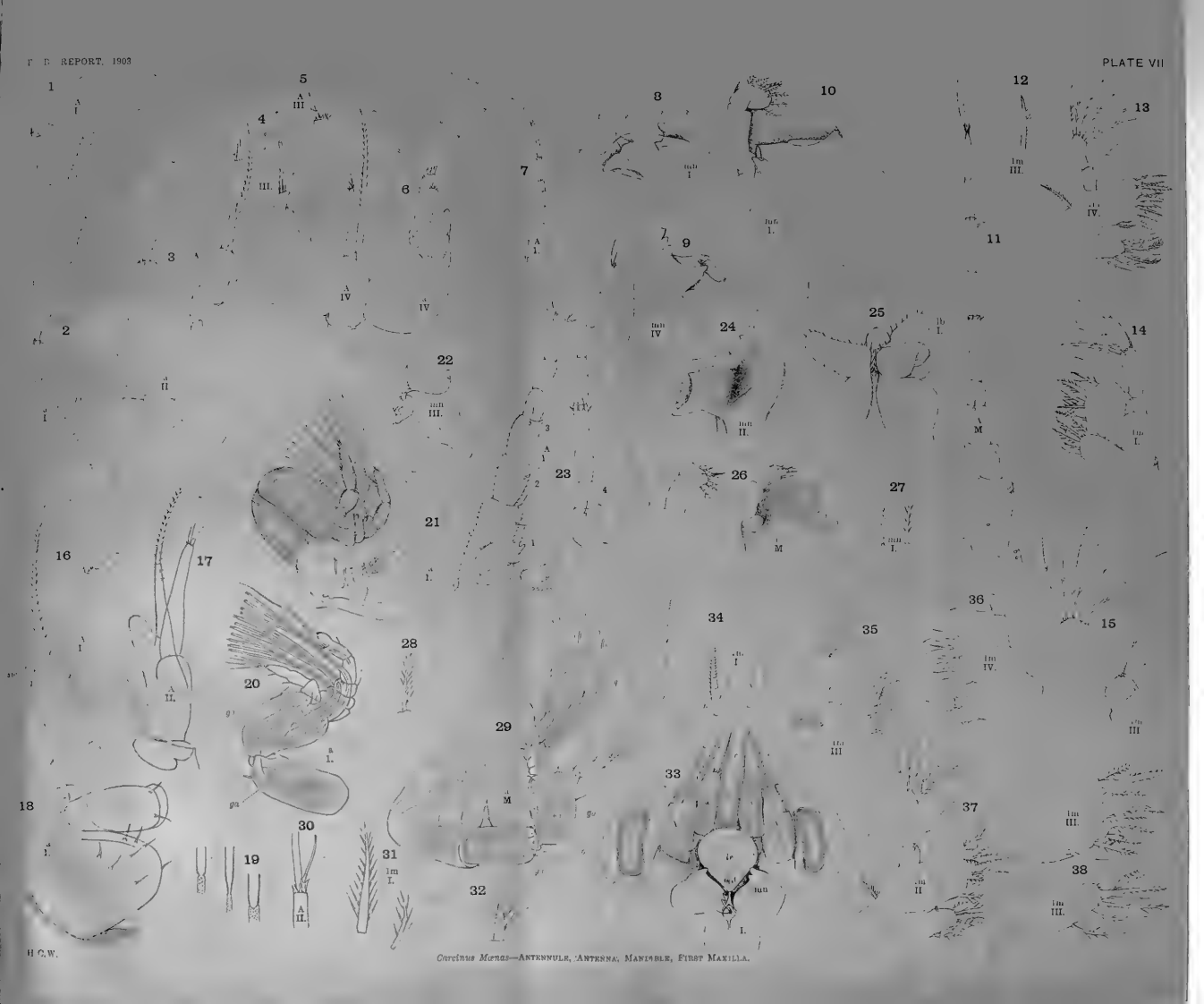
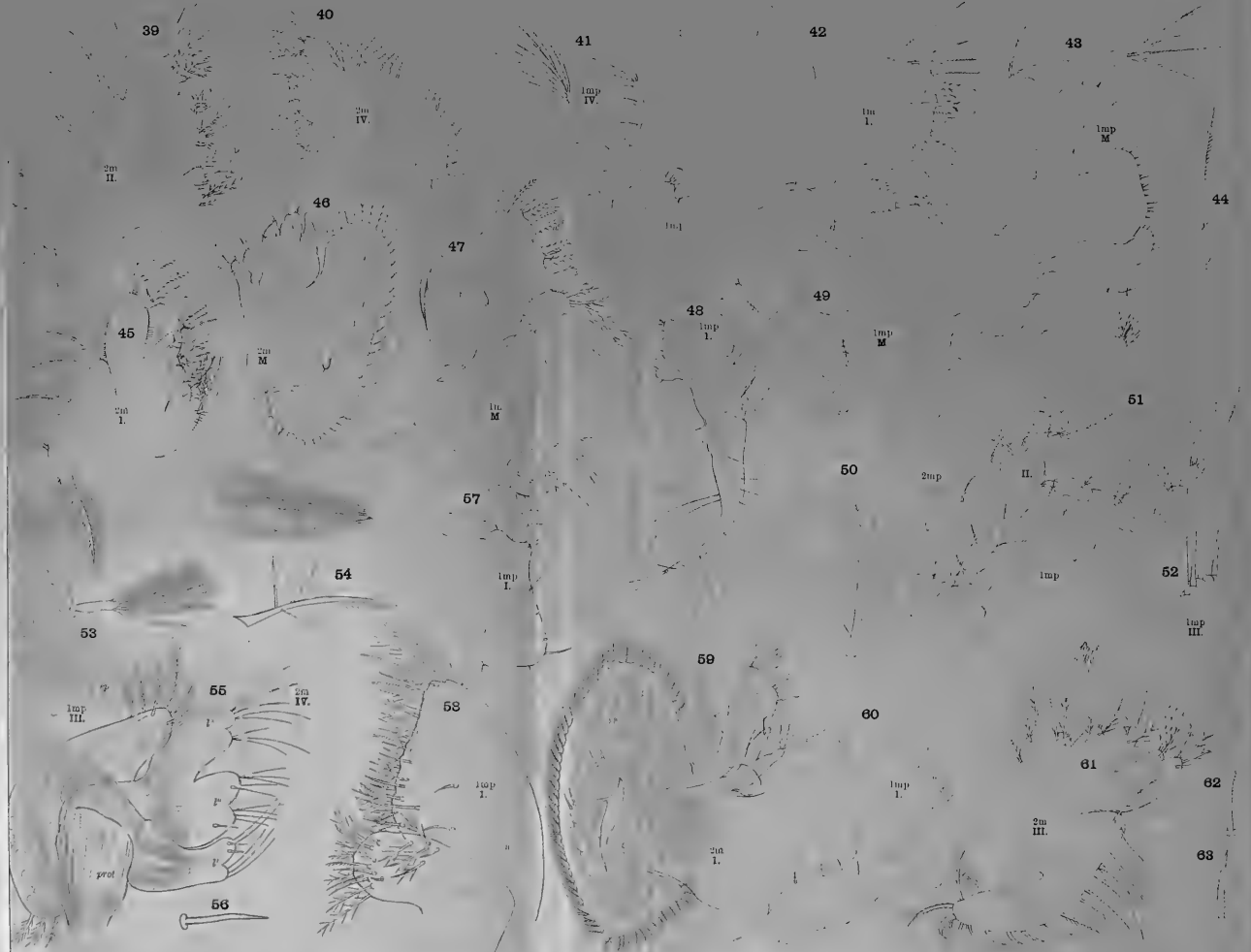


Carcinus Mœnas—Antennule, Antenna, Mandible, First Maxilla.

H. C. W.



H.C.W.

Carcinus Mœnas—First Maxilla (*continued*); Second Maxilla; First Maxillipede; Second Maxillipede (Fig. 61).

Curcinus Mœnas—Second Maxillipede: Third Maxillipede and Pereiopods.

H.C.W.

Carcinus Mœnas—Third Maxillipede (*continued*); Pereiopods.

Carcinus Mœnas—Pereiopods (*continued*): Abdomen: Pleopods: Telson.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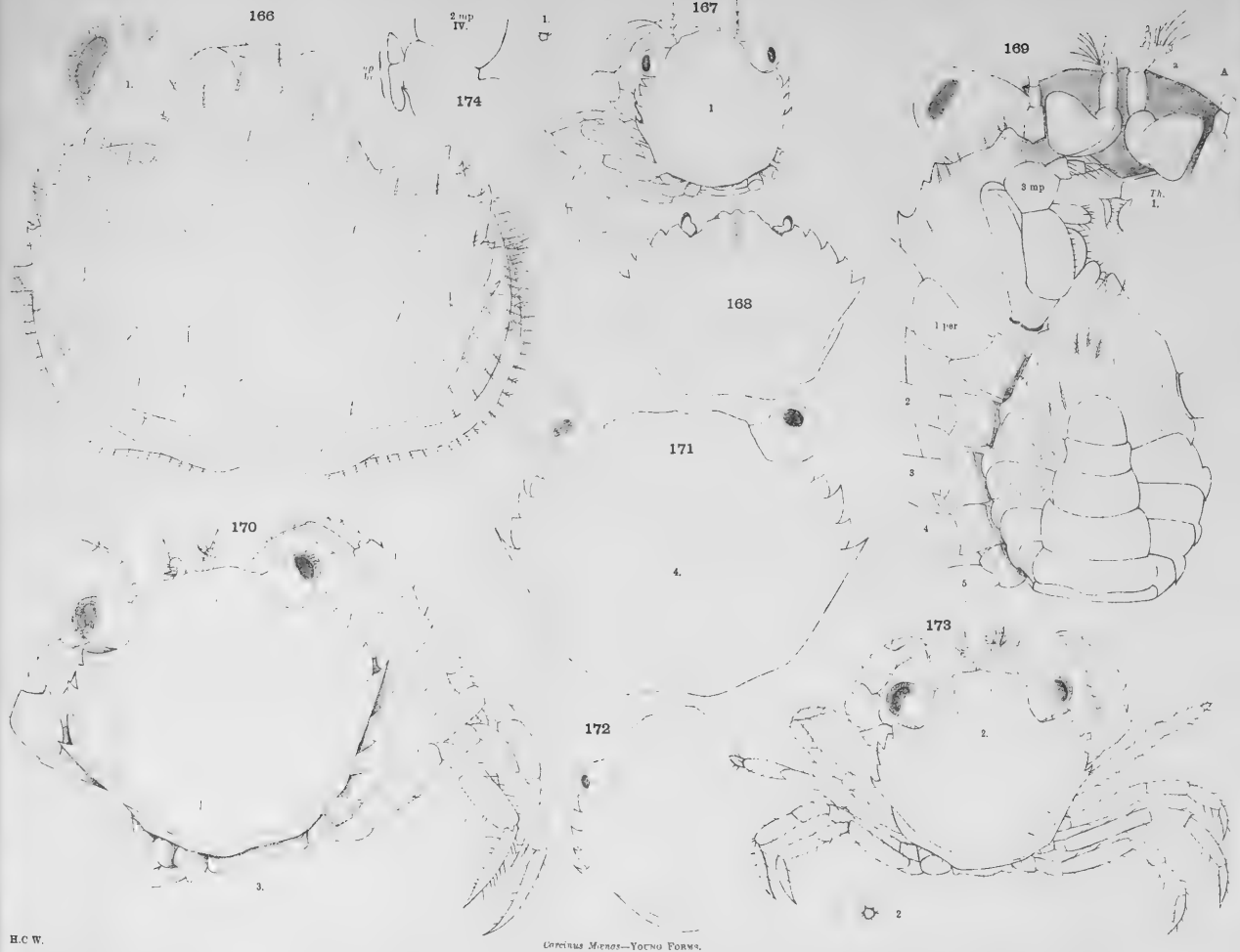
3 pleo
4 pleo
5 pleo



H.C.W.

Cancrinus Mœnos—Young Forms.

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IV.—REPORT ON THE OPERATIONS AT THE MARINE HATCHERY, BAY OF NIGG, 1902. By Dr. T. Wemyss Fulton, Scientific Superintendent.

In previous reports the methods and arrangements in connection with the hatching of plaice have been described, the principal conditions of successful working being the providing of a good stock of adult fishes to furnish the spawn, and an abundant supply of pure sea water of proper density for the hatching apparatus.

Since the erection of the hatchery on its present site in the autumn of 1899, it has been found possible, by means of the large, sunk, tidal pond, to keep a breeding stock from one season to another instead of renewing it yearly, as was previously the case. Under the former system it took a considerable time for the fishes to become accustomed to confinement, and many of them did not spawn, but retained their eggs, and died in an egg-bound condition, and thus the quantity of fertilised spawn obtainable from a given number of fishes was materially reduced.

At the end of the hatching season in 1901 the number of plaice remaining in the pond was found to be 767, most of which continued to thrive during the summer and autumn. To these others were added in the winter, the fishes being procured on board steam-trawlers provided with large covered tubs, through which a constant circulation of water was maintained, and which were transferred to the hatchery and the fishes placed in the pond. At the end of November 21 were obtained from Aberdeen Bay, in December 345 from Burghead Bay in the Moray Firth, and early in January 120 from off the coast of Caithness. As is always the case, a considerable number of the newly-introduced fishes succumbed later, chiefly in consequence of injuries and abrasions received in the course of capture by the trawl-net, and partly as the result of abrasions in the tubs, where they were sometimes confined for several days. The breeding stock for the season was estimated to number about one thousand plaice of both sexes.

During the latter part of January the temperature of the water in the pond was rather lower than usual, and few eggs were observed to have been shed until the early part of February. The first collection was made from the spawning-pond on the 8th February, when about 20,000 eggs were obtained, and on the next two days about the same quantity. Owing to a hard frost occurring on the following days the temperature of the water sank and spawning was checked, and no further collection was made until the 17th, when 40,000 were obtained. In the first half of March the number of eggs greatly increased, over two millions, and occasionally nearly three millions, being taken from the pond daily, the aggregate up to the 16th March being over 38,000,000. After this period the number diminished in March and still more in April, and the last collection was made on the 25th of April, viz. 20,000.

During the season the large total of 72,410,000 eggs were obtained, or about seven millions more than in the preceding year. It is believed that this large total was mainly owing to the thorough acclimatisation of the majority of the spawners during the year or more in which they were kept in the tank. It may be said that the fishes in the course of time become very tame, instead of withdrawing themselves and skulking at the bottom of the tank as is the habit with those newly introduced. They frequently swim about the surface at the sides of the tank in

expectation of being fed, and gather together when the attendant appears; they even take food from one's hands. They are fed nearly entirely on common mussels and thrive upon this diet. During most of the year two or three pecks a day suffice, but in the autumn, some months before the spawning season, they receive a more liberal allowance, up to four pecks, and soon get into very good condition.

In the process of incubation in the hatching apparatus, 16,630,000, or nearly twenty-three per cent, of the eggs died, a slightly higher percentage than in the previous year, when it was a little below twenty-one per cent., and which was probably owing to rather much overcrowding at times, and particularly when the burst of spawning occurred in the early part of March. The estimated number of fry produced was 55,700,000, and they were put into the sea partly in Lochfyne and mostly off the coast of Aberdeen. The Table giving the particulars from day to day is appended. It was prepared by Mr. H. Dannevig, who was in charge of the hatching work, and who was appointed at the end of the season to the newly-created office of Superintendent of Pisciculture under the Government of New South Wales, a Marine Hatchery, partly stocked with European fishes, which Mr. Dannevig took to Australia with him, being in course of erection near Sydney.

The tidal spawning-pond continues to give satisfaction, and has enabled the expense of the work to be very considerably reduced, since comparatively little pumping is required, except during the few months the hatching work is going on. It measures ninety feet in length by thirty-five in breadth, and has an average depth of nearly eight feet, one end being ten feet deep. The tide is admitted by a twelve-inch pipe controlled by valves. A still larger tidal-pond on the same principle has been constructed in connection with the new Marine Hatchery built at Port Erin by the Manx Government, which is nearly 100 feet long by 50 feet in breadth and from three to ten feet deep.

As will be seen from the Table the specific gravity of the water remained high and pretty uniform throughout the season, never sinking below 1027·3 and usually ranging about 1027·7.

Later in the summer, at the request of fishermen on the coast of Aberdeen, and Mr. Maconochie, M.P., the hatching of lobsters and edible crabs was undertaken at the hatchery by Dr. Williamson, the larval crabs and young lobsters being liberated at the northern part of the coast and in the Moray Firth. The number of larval crabs thus dealt with was about 4,500,000, and that of young lobsters, most of which were reared through several stages and in some cases had very nearly assumed the form of the adult, was about three thousand.

From the combination of the hatchery with the marine laboratory, and the provision of a large tidal pond, the expense of the hatching work is much diminished, the annual expenditure amounting to a little over £100, the principal items being the maintenance of the apparatus and plant, food for the fishes, and coals.

TABLE I.—Showing the Daily Progress of the Hatching Operations, as well as the Temperature and the Specific Gravity of Water in the Hatchery, the Pond, and on the Beach.

Date.	Number of Eggs Collected.	Number of Eggs found Dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Sea Water in the Hatchery at Noon.		The Sea Water in the Pond at Noon.		The Sea Water on the Beach at Noon.	
					Temp.	Sp. gr.	Temp.	Sp. gr.	Temp.	Sp. gr.
					Cent.		Cent.		Cent.	
Feb. 8	20,000	...	...	20,000	4·0	27·3	2·8	27·4	4·8	27·4
,, 9	10,000	...	...	30,000	3·7	27·3	3·1	27·4	5·0	27·5
,, 10	10,000	...	...	40,000	3·0	27·4	2·6	27·4	5·1	27·2
,, 11	...	...	...	40,000	2·5	27·3	2·2	27·6	4·9	27·0
,, 12	...	...	...	40,000	1·0	27·3	2·1	27·6	4·9	27·2
,, 13	...	...	...	40,000	0·1	27·2	1·6	27·5	4·8	27·0
,, 14	...	...	...	40,000	0·5	27·4	2·3	28·0	4·8	27·0
,, 15	...	...	...	40,000	0·0	27·5	2·4	27·8	5·0	27·1
,, 16	...	...	...	40,000	1·0	27·6	3·0	27·9	5·0	27·1
,, 17	40,000	25,000	...	55,000	1·5	27·5	2·6	27·6	5·2	27·2
,, 18	75,000	...	...	130,000	1·5	27·5	2·8	27·6	...	...
,, 19	90,000	...	...	220,000	1·0	27·6	...	...	...	...
,, 20	125,000	...	...	345,000	2·3	27·7	3·0	27·4	5·2	27·4
,, 21	180,000	...	...	525,000	2·1	27·6	3·2	27·2	5·0	26·9
,, 22	160,000	...	...	785,000	2·6	27·6	...	...	...	...
,, 23	220,000	30,000	...	975,000	3·1	27·8	...	...	...	...
,, 24	310,000	...	...	1,285,000	3·6	27·6	...	...	...	...
,, 25	250,000	...	...	1,535,000	4·2	27·7	...	...	...	...
,, 26	400,000	...	...	1,935,000	4·5	27·6	...	...	...	...
,, 27	950,000	...	...	2,885,000	4·1	27·7	...	...	...	...
,, 28	800,000	80,000	...	3,505,000	3·8	27·8	...	...	...	...
March 1	1,160,000	...	...	4,665,000	4·2	27·6	4·5	27·6	5·1	27·5
,, 2	1,300,000	50,000	...	5,915,000	4·7	27·5	4·5	27·4	4·8	27·6
,, 3	2,100,000	30,000	...	7,985,000	4·6	27·6	4·7	27·5	4·9	27·7
,, 4	2,600,000	...	...	10,585,000	4·9	27·5	4·6	27·5	5·2	27·4
,, 5	2,550,000	75,000	...	13,060,000	4·6	27·4	4·8	27·4	5·4	27·3
,, 6	2,450,000	80,000	...	15,430,000	5·0	27·3	5·1	27·5	5·5	27·4
,, 7	2,700,000	160,000	...	17,970,000	5·4	27·3	5·7	27·3	5·5	27·4
,, 8	2,500,000	200,000	...	20,270,000	5·7	27·5	6·2	27·4	5·6	27·4
,, 9	2,100,000	120,000	...	22,250,000	5·8	27·6	6·5	27·3	5·4	27·5
10	2,500,000	150,000	...	24,600,000	5·9	27·4	6·4	27·4	5·6	27·4
,, 11	2,400,000	350,000	...	26,650,000	6·0	27·6	6·7	27·5	5·8	27·3
,, 12	2,250,000	240,000	...	28,660,000	6·3	27·7	6·6	27·5	5·6	27·4

TABLE I.—*continued.*

Date.	Number of Eggs Collected.	Number of Eggs found Dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Sea Water in the Hatchery at Noon.		The Sea Water in the Pond at Noon.		The Sea Water on the Beach at Noon.	
					Temp.	Sp. gr.	Temp.	Sp. gr.	Temp.	Sp. gr.
					Cent.		Cent.		Cent.	
Mar. 13	2,100,000	480,000	...	30,280,000	6·2	27·6	6·4	27·5	5·9	27·4
,, 14	1,950,000	530,000	...	31,700,000	6·4	27·6	6·3	27·6	6·1	27·5
,, 15	1,800,000	360,000	...	33,140,000	6·8	27·7	6·1	27·6	6·2	27·5
,, 16	1,860,000	...	...	35,000,000	6·5	27·6	5·9	27·7	6·0	27·5
,, 17	1,650,000	450,000	...	36,200,000	6·4	27·5	6·2	27·6	6·2	27·6
,, 18	1,800,000	500,000	...	37,500,000	6·1	27·4	6·1	27·4	6·1	27·7
,, 19	1,700,000	740,000	...	38,460,000	6·2	27·5	6·2	27·5	5·9	27·6
,, 20	1,650,000	460,000	...	39,650,000	6·1	27·6	5·9	27·4	6·0	27·6
,, 21	1,650,000	800,000	...	40,500,000	6·3	27·7	6·2	27·5	6·0	27·5
,, 22	1,650,000	540,000	...	41,610,000	6·4	27·6	6·4	27·6	6·1	27·7
,, 23	1,700,000	700,000	...	42,610,000	6·6	27·6	6·2	27·5	6·2	27·6
,, 24	2,100,000	650,000	...	44,060,000	6·7	27·5	6·1	27·5	6·3	27·5
,, 25	1,600,000	...	...	45,660,000	6·2	27·6	6·1	27·6	6·4	27·6
,, 26	1,250,000	...	6,500,000	40,410,000	6·3	27·6	5·7	27·7	6·1	27·6
,, 27	1,140,000	200,000	...	41,350,000	6·1	27·8	5·8	27·8	6·3	27·9
,, 28	800,000	...	...	42,150,000	6·7	27·7	5·6	27·7	6·2	27·8
,, 29	870,000	220,000	4,750,000	38,550,000	6·6	27·6	5·5	27·6	6·3	27·5
,, 30	700,000	...	...	38,750,000	7·1	27·6	5·8	27·6	6·1	27·6
,, 31	960,000	...	...	39,710,000	7.0	27·7	5·9	27·7	6·1	27·8
Apl. 1	1,200,000	560,000	...	40,350,000	6·2	27·8	6·3	27·9	6·2	27·7
,, 2	1,300,000	690,000	6,250,000	34,710,000	6·1	27·9	5·9	27·9	6·1	27·6
,, 3	1,100,000	400,000	...	35,410,000	6·7	27·8	5·8	27·8	6·1	27·8
,, 4	700,000	360,000	...	35,750,000	6·2	27·8	6·2	27·8	6·1	27·6
,, 5	750,000	420,000	4,800,000	31,280,000	6·3	27·8	6·1	27·7	6·3	27·6
,, 6	400,000	300,000	...	31,380,000	6·5	27·6	6·4	27·8	6·4	27·6
,, 7	600,000	330,000	...	31,650,000	6·8	27·6	6·7	27·6	6·6	27·7
,, 8	740,000	280,000	...	32,110,000	7·0	27·5	6·7	27·7	6·8	27·8
,, 9	660,000	440,000	5,500,000	26,830,000	7·3	27·4	6·8	27·6	7·1	27·3
,, 10	650,000	560,000	...	26,920,000	7·3	27·5	6·9	27·6	7·0	27·5
,, 11	650,000	600,000	...	26,970,000	7·2	27·7	7·1	27·7	7·0	27·6
,, 12	630,000	740,000	...	26,860,000	7·0	27·6	7·2	27·8	6·9	27·7
,, 13	600,000	470,000	...	26,990,000	6·8	27·7	7·4	27·6	6·7	27·6

TABLE I.—*continued.*

Date.	Number of Eggs Collected.	Number of Eggs found Dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Sea Water in the Hatchery at Noon.		The Sea Water in the Pond at Noon.		The Sea Water on the Beach at Noon.	
					Temp.	Sp. gr.	Temp.	Sp. gr.	Temp.	Sp. gr.
					Cent.		Cent.		Cent.	
Apl. 14	610,000	540,000	...	27,060,000	6·5	27·7	7·3	27·6	6·8	27·5
,, 15	580,000	300,000	4,300,000	23,040,000	6·5	27·8	7.5	27·5	6·5	27·4
,, 16	...	360,000	...	22,680,000	6·7	27·6	7·4	27·5	6·6	27·4
,, 17	500,000	300,000	...	22,880,000	6.8	27·4	7·4	27·6	6·7	27·4
,, 18	350,000	240,000	...	22,990,000	6·9	17·5	7·6	27·6	6·8	27·5
,, 19	380,000	280,000	5,600,000	17,490,000	7.3	27·5	7·8	27·5	6·8	27·6
,, 20	350,000	...	...	17,840,000	7·4	27·5	7·8	27·6	6·9	27·6
,, 21	200,000	220,000	...	17,820,000	7·4	27·6	7.9	27·6	6·9	27·4
,, 22	...	...	7,200,000	10,620,000	7·8	27·4	7·9	27·4	6·9	...
,, 23	260,000	...	...	10,880,000	8·1	27·4	7·8	27·4	6·7	27·4
,, 24	...	20,000	...	10,790,000	...	...	...	...	...	...
,, 25	20,000	...	...	10,810,000	...	...	...	...	...	...
,, 26	...	...	...	...	...	...	10·0	27·0	...	...
,, 27	...	...	...	...	...	...	...	...	...	...
,, 28	...	...	...	...	...	...	...	...	...	...
,, 29	...	...	8,700,000	2,110,000	...	...	...	...	...	...
,, 30	...	...	...	...	...	...	...	...	...	...
May 1	...	...	2,100,000	...	...	...	...	...	...	...
Totals,	71,410,000	16,630,000	55,700,000							

TABLE II.—Showing particulars in connection with the Distribution of Fry.

Date.	Locality.	Temp. of the Water.	State of the Tide.	Condition of Weather.	Number of Fry Planted.
Mar. 26th	Two miles off Black Dog in 20 fathoms.	5·1°	L.-W.	N.W. wind, strong.	6,500,000
,, 29th	Off Girdleness in 30 fathoms.	5·3°	4 h. ebb.	Calm.	4,750,000
April 2nd	Between Don Mouth and Black Dog in 15 fathoms.	5·2°	2 h. flood.	Wind W., light.	6,250,000
,, 5th	Off Black Dog in 15-20 fathoms.	5·4°	...	Wind N.W.	4,800,000
,, 9th	Off Don Mouth in 20 fathoms.	5·5°	...	Wind variable.	5,500,000
,, 15th	Off Girdleness in 20 fathoms.	5·1°	...	N.W. swell.	4,300,000
,, 19th	Off Girdleness in 25 fathoms.	5·6°	...	Wind West, choppy sea.	5,600,000
,, 22nd	In Lochfyne, halfway between Inveraray and Strachur, ½ flood.	6·8° (sp. gr. 26·1)	...	Wind S.E. strong.	7,200,000
,, 28th	In Lochfyne, halfway between Inveraray and Strachur, ½ flood.	...	...	...	8,700,000
May 2nd	Off Girdleness.	...	...	...	2,100,000

V.—THE DISTRIBUTION, GROWTH, AND FOOD OF THE ANGLER (*Lophius piscatorius*). By Dr. T. Wemyss Fulton, F.R.S.E., Scientific Superintendent.

I. Distribution.

With regard to distribution, the angler is common both in the inshore waters and in the greatest depths at which the trawlers work, but it seems to be most abundant in water of moderate depth. In the course of the investigations made on board steam-trawlers from Aberdeen specimens were taken on the north-eastern grounds in from seventy to eighty fathoms. Bourne took one on the west coast of Ireland in 200 fathoms,* Brown-Goode records specimens taken on the eastern side of the Atlantic from 84, 142, and 365 fathoms,† and Holt and Calderwood from 115 fathoms on the west coast of Ireland.‡

In the course of the trawling investigations 1956 specimens were taken in recorded hauls, 155 on the distant grounds, 256 in Aberdeen Bay, and 1549 in the Moray Firth. The amount of fishing in the different areas was, however, dissimilar, but the average number taken per ten hours' trawling in the deep water on the north-eastern grounds, south-east and south of the Shetland Isles, was 6·1, in Aberdeen Bay it was 15·9, and in the Moray Firth 24·4. On the Great Fisher Bank in thirty-four fathoms only five were taken in nine hauls in May, the proportion being 1·4 per ten hours' trawling. But while the proportion remained fairly steady on the deep-water grounds, it fluctuated very considerably in the inshore waters. In September on the former it was nearly 7 in ten hours, in October 6, in May 5, in June 9. In the Moray Firth in those months it was 5, 3, 66, and 6, and in Aberdeen Bay 4, 16, 68, and 5. The averages for the various months in Aberdeen Bay and the Moray Firth are as follows :—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Aberdeen Bay,	5	2	0·0	-	68	5	27	-	4	16	8	0·0
Moray Firth, .	6	57	10	-	66	6	1	22	5	3	10	36

The proportions in the two areas do not correspond, and probably show, therefore, that the abundance depends upon local conditions, as the presence or absence of other fish, such as herrings, sprats, or shoals of young whitings, which attract predaceous fishes. The angler, notwithstanding its apparently slow power of movement, seems to be able to collect where fishes, and especially small fishes, are abundant. Whether this was the cause of the very large numbers taken in inshore waters in May (609) is not clear. Whitings and haddocks, both large and small, were at least very scarce at the time on the same grounds.

The larger proportion of the anglers taken in the Moray Firth were got at Burghead Bay on the south coast, in water from five or six to about twenty fathoms deep, and they were most numerous in February, when as many as ninety were taken in a single haul, the average number per ten hours' trawling being 103. In this case the presence of a shoal of

* *Jour. Mar. Biol. Assoc.*, New Ser., i., p. 310.
† Oceanic Ichthyology, p. 485.
‡ *Sci. Trans. Roy. Dublin Soc.*, v., Ser. ii., p. 415.

herring was the cause; and not only anglers, but numerous cod, large codling, and saithe, and some ling and hake, were also attracted. There were few haddocks or whitings on the ground. The average numbers of anglers taken on this ground in the various months, per ten hours of trawling, were:—January 16, February 103, March 32, May 75, June 25, July 12, August 47, September 5, and December 32; no hauls were made on it in August, October, or November.

It is noteworthy that very young anglers, but still quite large enough to be retained in the meshes of the otter-trawl, were exceedingly scarce, a remark that indeed applies to the smaller individuals of many other forms. From the great development of the head, comparatively small specimens would be caught if they entered the net. Occasionally specimens under seven inches are obtained, but not very commonly. Among the measurements of 644 at different places and times I find the following:—

	Under 8 inches.	Under 7 inches.	Under 6 inches.	Under $5\frac{1}{2}$ inches.	5 inches.
No. - -	57	30	13	6	1
$^0/_0$ of Total -	8·8	4·6	2·0	0·9	0·2

The comparative scarcity of the young anglers is very probably owing to the reason that I have elsewhere suggested to account for the absence of other young forms. They are obviously uncommon on bottoms suited for trawling, or they would be taken in much greater numbers. A pelagic habit in their case is out of the question much after the post-larval stage, and it is probable, as I suggested some years ago,* that the young anglers frequent rocky algæ-covered ground where they can have shelter and also suitable food. This view is supported by the large number of small anglers that were taken in one haul in November on the edge of such rocky ground—viz., off Lybster, on the Caithness coast, in from twenty-three to thirty-four fathoms, where the trawl-net not uncommonly comes to grief. Of thirty-six anglers taken in this haul no less than twenty-seven were under 200 mm. ($7\frac{7}{8}$ inches), and another was 201 mm. They are included above, and thus make the proportion of the small anglers as indicated much greater than in ordinary circumstances. The size ranged from 128 to 198 mm. ($5\frac{1}{16}$–$7\frac{3}{16}$ inches), the average being 153·5 mm., or a little over six inches. These young anglers were feeding on sand-eels, which had probably tempted them from their rocky fastnesses. The next sizes were 277, 298, etc., mm.

Of other 210 anglers got at various times in other hauls in the Moray Firth only three were under 20 cm. Two of these measured 198 mm., one got in June in from five to fourteen fathoms in Burghead Bay, and the other in the Dornoch Firth in July in from eight to eleven fathoms. At one point of the Dornoch Firth, it may be said, the bottom consists of rocks, extending far out. Another caught in the latter place in November measured 127 mm., or exactly five inches.

Since this specimen appears to be one of the smallest recorded, I give the following particulars. The exact colouring was not noted at the

* *Eight Ann. Rep., Part III.*, p. 177 (1889).

time, but in my notes it is described as richly speckled and mottled, and my impression is that the mottling was mostly brown and green. In the preserved condition (formaline) it is darkish grey above, with a few dozen blackish, somewhat ocellated, spots, scattered about, and numerous less dark brownish patches with a digitate border like the marginal fringes. The terminal portion of all the fins is black, most marked in the membrane between the rays, and on the dorsal and terminal third of the lower surface of the pectorals. It is soft and gelatinous and the mucoid tissue abounds, especially on the under surface of the head. The fish weighed $1\frac{1}{4}$ ounces.

The following measurements are from the preserved specimen. Extreme length, 124 mm.; length behind anus, 57 mm.; and from anus to root of caudal, 32 mm. Greatest breadth of head, 48 mm.; greatest height, 20 mm.; diameter of eye, 6 mm.; distance between eyes, 12 mm.; distance from tip of snout to base of third dorsal ray, 28 mm.; gape with mouth closed, 30 mm.; projection of lower jaw beyond snout, 7 mm.; width behind pectorals, 20 mm. Length of free portion of first dorsal ray, 6 mm.; of second, 17 mm; of third, 14 mm. Length of pectoral, 30 mm.; breadth expanded, 28 mm.; length of ventrals, 23 mm.; breadth, 9 mm.

The first dorsal spine is destitute of lateral appendages or fringes, but bears on the top a dark grey membranous horizontal straight strip, 5 mm. long, and nearly 2 mm. in vertical breadth, poised in the middle on the apex. It thus resembles a T. The strip is bluntly pointed at each end, and provided below with a number of lighter-coloured, hair-like filaments about 2 mm. long. The spine arises about 5 mm. from the snout, and in examining it in water I was struck with the resemblance the terminal portion presented to a small crustacean, as an amphipod, the pendulous filaments representing the legs. If the angler sways the spine about in the water, one can understand how small fishes may be deceived and snap at it.

The second and third spines are feathered laterally with membranous fragments, the third most densely, and they are here darker; and similar appendages exist on the free portions of the other three spines, the free portion of the fourth spine measuring 10 mm.

In Aberdeen Bay, among 131 anglers measured, six were under 200 mm., one was 159 ($6\frac{1}{4}$ inches), and the others from 187 to 198 mm. Three, including the smallest, were taken in November, two in from seven to twenty fathoms, and the smallest in fifteen-and-a-half fathoms, one in May and two in July. At the Dog Hole off Aberdeen, where the water is deep, one of eighteen measured 170 mm.; it was caught on 13th May.

The proportion of the young anglers on the deep-water grounds appears to be higher than on the inshore trawling grounds. Of fifty in May, in sixty-five fathoms, ten were under 200 mm., ranging from 155 to 197, the average length being 182·1 mm., or $7\frac{3}{16}$ inches. In September, seven of twenty-two were under 200 mm., the size ranging from 165 to 191 mm., and the average length being 181·3 mm., or $7\frac{1}{8}$ inches. Other two under 200 mm. were taken in the Forth in July measuring 165 and 196 mm. respectively. The higher proportion in the deep water may indicate the comparative absence of shelter there, and it shows in all probability that spawning and the developmental changes may take place far from land.

The larger anglers are as a rule got in deeper water than those which are of moderate size, as, for example, in thirty and fifty fathoms in the Moray Firth. They sometimes, however, come into quite shallow water. An interesting case of the kind occurred in June in the Dornoch Firth.

Going ashore on a Sunday morning in the trawler's boat we observed a number of boys running to the beach in the harbour and picking up stones commence to throw them into the water. It at first appeared as if the action was meant for us, because the feeling against trawlers is very strong in the locality, and we were relieved to find the boys were attacking a large angler which had got into the shallow water and was floundering about there. It was pulled out by the tail and killed; it measured nearly three feet.

There appears to be, at least in the Firth of Forth, a migration of young anglers in summer. During the early months of the year they are very scarce, but increase very considerably in numbers with the advancing season and increase of temperature.

II. Rate of Growth.

The information concerning the rate of growth of the angler is somewhat scanty, although it is sufficient to enable some conclusions to be drawn. The first thing to be considered is the period of spawning. Ripe males have come under observation earlier than ripe females. On 3rd November a male, thirty-two inches long, caught off Lossiemouth in the Moray Firth, was quite ripe. On 20th and 24th December two quite ripe males were trawled in Burghead Bay, in from seven to fifteen fathoms, a few miles from shore; one was twenty-seven and the other twenty-three inches in length. In May one was taken on Smith Bank also ripe, and thirty-six inches long. Holt found a ripe one in March, twenty-five inches long, taken in 115 fathoms.* Females apparently almost ripe, with very large ovaries, were taken in February on the East Coast, and others approaching ripeness. On May 25th one was caught nearly ripe, and on 7th July one, of thirty-six inches, that was approaching ripeness, the ovaries being more than seventeen feet in length. On 3rd November, in the Moray Firth, a female of thirty-five inches was about half-developed. On 18th January, off the Caithness coast, in from eighteen to twenty-five fathoms, one of thirty-three inches was approaching ripeness. Holt found a spent female, of thirty inches, in June, and one of forty inches, also spent, in March.

The floating mucoid band in which the eggs are imbedded has been obtained in June, July, and August.† One was got in the trawl on 1st August in from 8–12 fathoms in Aberdeen Bay, the only instance of the kind that came under my notice during the trawling investigations; but, from enquiries, I think such instances are not uncommon, although the trawlers do not recognise that the substance is fish-spawn.

The mucoid substance was perfectly clear, transparent, and glairy, the eggs being readily detected by the black pigment of the advanced embryos and the conspicuous oil-globules. As in other cases where the spawn has been found, the embryos were far advanced; some, indeed, had already hatched. Part of the mass was kept in tanks at the Laboratory, and within a few days all the eggs hatched out. Some of the larvæ were kept alive until 18th August, long after the yolk had disappeared, and drawings and preparations were made; but they all gradually died off, evidently from starvation, although unfiltered water was used and tow-nettings added. Besides the dense black characteristic pigment, there was, it may be said here, much bright canary yellow, and in the older specimens the rudiment of the fourth ray of the first dorsal was formed. The little post-larval angler, about 10 mm. long, has a very odd appearance

* *Rep. Council Roy. Dublin Soc.*, 1891, p. 245.

† The eggs and embryo described by Prince in the *Ninth Annual Report*, p. 343, from Dunbar, were procured at the beginning of July, not in February.

as it swims through the water by the rapid vibration of the pectorals and tail, the long black ventrals projecting downwards and outwards and quiescent below, and the almost equally long, black-tipped rays of the first dorsal standing erect on the top of the head. The eyes are large, deep ultramarine in colour, and look upwards and forwards, and the mouth is usually gaping, each jaw being provided with a row of ten or twelve minute pointed teeth. They were observed to dart and snap at particles in the water. At this stage the head is about one-fourth the length of the body, and more than a third deeper; in a front view the breadth of the head is about $\frac{7}{10}$ of the height.

The only post-larval form that appears to have been obtained was taken in twenty-five fathoms in a mid-water net, on 30th August, fifteen miles off the Isle of May.* It was only 7 mm. in length, or a little over a quarter of an inch, showing that a reduction in length occurs in development.

From these facts it appears that the angler spawns from March to the beginning, or the middle, of July, and perhaps into August, and probably mostly in May. The length of time which the eggs take to hatch has not been determined. The nature of the yolk, and the advanced condition of the larva on issuing, argue a more prolonged period for the embryonic development than in the case of ordinary pelagic eggs—for the egg of the angler is essentially a demersal egg when removed from the mucoid substance. On the other hand, the temperature of the surface water in May, and still more in June and July, is high, and, judging from the period in the case of a large pelagic egg like that of the plaice, it is probable the eggs of the angler require over three weeks in May and more than a fortnight in July before hatching occurs. On this reasoning the larval anglers would appear in the greatest numbers in summer from the end of May to August, and the occurrence of the little post-larval specimen as late as 20th August is noteworthy.

The smallest anglers obtained were taken in the following months:—

CENTIMETRES.

	12	12·5	13	13·5	14	14·5	15	15·5	16	16·5	17	17·5	18	18·5	19	19·5	20
Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Feb.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mar.	-	-	-	-	*1	-	-	-	-	-	-	-	-	-	-	-	-
April	-	-	-	-	†1	-	-	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	1	1	-	1	2	3	-	-
*June	-	-	-	-	-	-	-	-	-	-	-	-	-	-	‡3	-	1
*July	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-
*Aug.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*Sept.	-	-	-	-	-	-	-	-	1	-	-	1	-	-	§3	-	-
Oct.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nov.	-	2	2	2	2	8	2	2	2	3	-	2	2	1	-	2	2
Dec.	-	-	-	-	-	-	-	-	†1	-	-	-	-	-	-	-	-

* At beginning of month.
† By *Garland* in Firth of Forth.
‡ One by *Garland*.
§ Two by *Garland*.

* M'Intosh & Prince, *Trans. Roy. Soc., Edinburgh*, vol. xxxv., p. 869.

It is obvious that the two specimens about 14 cm. (5½ inches) taken in March and April—one of which was obtained by the "Garland" on 16th April at Station I. in the Firth of Forth, and the other found on the beach at St. Andrews after a storm*—belong, at least, to the preceding year. That is no doubt also the case with the specimens in May, two of which measured 168 and 170 mm., the third 181 mm., and the others 186, 187, 190, 193, and 194 mm., all being procured in the deep water to the east of the Shetlands. Those obtained in September—of which three, measuring 165 mm., 178 mm., and 190 mm., were got in sixty-five fathoms, south-east of Sumburgh Head, on the 3rd of the month, and two on 6th and 11th by the "Garland," one in St. Andrews Bay and the other in the Forth—are doubtless also fish of the preceding year. The others were procured as follows. In June, two, each 190 mm., at the beginning of the month, one in the Moray Firth, and the other in Aberdeen Bay; a third about the same length was taken by the "Garland" on 6th June in St. Andrews Bay, and the fourth, measuring 200 mm., at the beginning of the month in the Moray Firth. In July, three were obtained in the Moray Firth between the 1st and the 4th of the month, and they measured 195, 198, and 198 mm.; another 192 mm. long was taken in Aberdeen Bay on 30th July. I think it is evident that all these specimens, ranging from five-and-a-half to seven-and-three-quarter inches, belong to the previous year.

The November specimens, however, appear to be in another category. The smallest measured 127 mm. and 128 mm., or just about five inches, and judging from what we know about the rate of growth of the haddock and whiting, and the absence of comparable sizes in the preceding months, it is highly probable that these young anglers—one, the smallest, got in the Dornoch Firth on 5th November, and the others off Lybster on 8th November, in from twenty-three to thirty-four fathoms—were spawned in the same year. This would show fairly rapid growth from the spawning period, as above assigned. Those obtained in March and April, which measured five-and-a-half inches, may be regarded as about, or nearly, one year old.

With the view of determining if possible the limits of the yearly groups or generations of the smaller anglers, I have tabulated the measurements of those under 60 cm. (23½ inches), and give them in the following Table in centimetre groups :—

*M'Intosh and Masterman, Brit. Food Fishes, p. 155.

[Table.

Cm.	Deep Water.			Moray Firth and Aberdeen Bay.					
	May.	Sept.	Oct.	May–June.	June–July.	July–Aug.	Sept.	Nov.	Dec.
10	...	...	...	...	...	...	...	...	...
11	...	...	...	...	...	...	...	...	...
12	...	...	...	...	...	...	...	2	...
13	...	...	...	...	...	...	...	4	...
14	...	...	...	...	...	...	...	10	...
15	...	...	...	...	...	...	...	4	...
16	1	1	...	...	...	...	...	5	...
17	1	1	...	...	...	...	...	2	...
18	3	...	...	...	...	...	...	3	...
19	3	1	...	2	3	1	...	2	...
20	2	...	...	1	2	1	...	3	...
21	10	2	...	...	1	3	...	1	...
22	1	...	...	...	3	4	...	...	...
23	1	...	3	...	3	4	...	1	...
24	1	3	1	...	2	7	...	2	...
25	...	...	...	...	...	10	...	...	1
26	...	...	...	...	1	7	1	2	...
27	1	...	...	...	2	3	...	4	...
28	...	...	...	1	3	7	1	2	...
29	1	2	2	2	1	7	2	1	...
30	1	...	...	...	...	2	2	5	1
31	4	...	...	1	...	1	1	2	2
32	1	...	...	...	...	1	1	4	...
33	2	...	...	2	...	3	2	1	1
34	2	...	...	2	2	1	...	1	...
35	...	...	...	1	3	3	...	4	1
36	...	1	...	...	2	2	...	5	1
37	...	...	...	1	1	2	2	...	2
38	...	...	...	1	2	2	1	2	...
39	1	...	...	3	2	2	2	1	1
40	...	...	1	...	2	6	...	1	1
41	...	...	...	1	1	8	...	...	...
42	...	...	...	...	1	6	...	...	1
43	...	...	...	...	1	6	1	...	1
44	1	...	1	...	2	4	...	...	1
45	...	...	...	...	1	...	...	2	1
46	...	...	...	...	...	2	...	1	...
47	...	...	...	...	2	2	...	...	...
48	...	...	...	...	...	1	...	1	2
49	...	...	...	...	1	1	...	...	...
50	...	...	...	...	...	...	...	...	...
51	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	1
53	...	...	...	...	...	...	...	...	1
54	...	...	...	...	1	1	...	1	...
55	...	...	...	...	...	...	...	3	...
56	...	...	...	...	1	1	...	...	...
57	...	...	...	...	...	...	...	...	1
58	...	...	...	1	1	2	...	1	...
59	...	...	...	...	1	1	...	...	1
60	...	...	...	...	...	...	...	...	...

In most cases, owing to the paucity of specimens, the distinction between the groups is not very sharp, even when grouped in ·5 cm. and graphically exhibited, but still it appears fairly certain that there are three annual series or generations represented in the Table. Taking the first series in November. it begins at 127 mm. and extends apparently to

214 mm. This would give a range in size of 87 mm. or $3\frac{7}{16}$ inches, and an average size for the thirty-six specimens of 161·5 mm. or $6\frac{3}{8}$ inches, the maximum being about $8\frac{3}{8}$ inches and the minimum 5 inches. In that case the two specimens of five-and-a-half inches caught in March and April would be under the mean size—as, of course, they might well be. The haddock, it may be said, whose main hatching or larval period is about the early part of April, attains on an average a length of close upon seven inches (169·6 mm.) in November, the ascertained range, from many hundreds of specimens, being from 127 mm. to 220 mm.* The spawning of the angler is later; but, on the other hand, the adult is very much larger than the adult haddock and its growth ought to be quicker, and unless the transformation stages of the angler cause considerable retardation of growth in length, the sizes above given probably represent approximately the real sizes at the period. The end of the group, however, may possibly be at 180 mm., or about $7\frac{1}{8}$ inches. On that basis the calculated mean size would be 10 mm. less—viz., 151·0 mm., or a little under six inches. It is also to be borne in mind that the smallest anglers of the true natural series are probably absent.

The second series in the November specimens begins apparently at 235 mm., there being none between this and 214 mm. The specimens at the different sizes are somewhat irregular in numbers, but the end of the group appears to occur at 402 mm. or $15\frac{13}{16}$ inches, the average size being about 318 mm. or twelve-and-a-half inches. This would represent a mean-growth in a year, from the average of the first group, of a little over six inches. The series may, however, end at 380 mm., in which case the mean-size would be about 30·5 cm. or twelve inches.

If we turn now to the next best series of measurements, that for the end of July and beginning of August, it will be seen that the first series represented begins at 19 cm.—192 mm.—or at a little over seven-and a-half inches. Its termination is less clear, but seems to be at 315 mm.—it might be 306 mm. The mean-size of the series is by computation 252·5 mm., and by the graphic system 250 mm., or about $9\frac{7}{8}$ inches. On the basis above stated, this would indicate a growth of the same series from the November preceding of about 90 mm. or three-and-a-half inches —that is to say, in the months December–July—and a growth to the following November of about 68 mm. or $2\frac{3}{4}$ inches, that is in August, September, and October, the aggregate being about six-and-a-quarter inches, which fairly corresponds.

The second group at the beginning of August begins at 319 mm. or about $12\frac{5}{8}$ inches, and appears to extend to 495 mm. or nineteen-and-a-half inches, the mean-size being about 40·5 cm. or sixteen inches. The fish in this series may be regarded as about two years and three months old. The average increment in a year as computed from the average of the previous series amounts to about 15·5 cm., or a little over six inches, which also approximately corresponds with the increment deduced from comparison of the averages in the previous cases. Compared with the second series in November, there is a difference in the mean-size in the two cases of 87 mm., or nearly three-and-a-half inches, which represents approximately the amount of growth from November to the beginning of August. The facts seem to show that the growth of the angler is more regular throughout the year than in the case of the haddock, whiting, plaice, and dab, being less retarded in winter and less accelerated in summer. This is what might be expected in a fish inhabiting, as a rule, water of some depth, where the temperature changes at different seasons are less pronounced.

* *Twentieth Annual Report, Part III.*, p. 402.

The third series in November and August are obviously imperfect, comparatively few anglers having been obtained, or at least measured, and the remark also applies to most of the series in the other months, although as a rule three groups are manifestly represented. It would have been of interest to compare the series got in the deep water with those from the Moray Firth and Aberdeen Bay, but they are imperfect. The indications, however, are that growth is slower, or at least that at a corresponding date the first series represented—fish about and over one year of age—are somewhat smaller in the deep water off the Shetlands where, as with the haddock and whiting, etc., spawning is probably later.

The measurements of anglers obtained by the "Garland" are not represented with sufficient minuteness to be of much value in studying the rate of growth, since they are grouped in inches. I give here, however, for comparison those for two years in the Forth and St. Andrews Bay :—

	SIZE IN INCHES.																			
	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	22 +	23 +	25 +
Jan. .	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Feb. .	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Mar. .	-	-	-	-	-	-	1	-	-	-	1	-	1	-	2	-	-	-	1	5
April .	1	-	-	-	1	-	-	1	1	-	-	3	-	-	1	2	-	-	-	4
May .	-	-	-	1	-	-	2	1	1	1	1	-	-	-	-	-	-	-	-	2
June .	-	2	1	2	1	1	1	3	-	4	2	-	-	1	1	1	-	-	4	1
July .	-	-	1	4	-	1	1	-	5	2	-	-	-	1	-	-	-	-	-	-
Aug. .	-	-	-	3	3	7	6	3	1	3	3	1	1	3	-	1	2	1	-	3
Sept. .	-	-	2	2	12	7	9	9	7	7	8	2	-	2	-	-	-	-	1	4
Oct. .	-	-	-	3	7	10	4	5	8	4	2	2	1	-	-	1	-	-	-	-
Nov. .	-	-	-	-	7	1	3	6	7	1	-	-	-	-	1	-	-	-	1	3
Dec. .	-	1	-	2	1	-	-	6	11	4	1	2	-	1	-	1	-	-	-	4

The observations therefore appear to warrant the following statement as approximately representing the growth of the angler :—

Approximate Age.	Length. Smallest.	Largest.	Mean.
Six months, . . .	*5 inches.	$8\frac{3}{8}$ inches.	$6\frac{3}{8}$ inches.
One year and 6 months,	9 ,,	$15\frac{13}{16}$,,	$12\frac{1}{2}$,,
†Two years and 6 months,	$14\frac{1}{2}$,,	21–22	18–$18\frac{1}{2}$,,

When three years old, supposing a little less than the same rate of increase continues—and in fishes growth is not usually much reduced in rapidity before the period of maturity is reached—the angler will measure approximately twenty-one inches in length, and when four years old about twenty-six or twenty-seven inches. The information as to the size at which maturity is first attained is not extensive, but males may be

* Smallest caught.

† Derived from computing the second group in August or at the beginning of November.

found ripe at the size stated. Females probably do not become mature as a rule until over thirty inches in length, and the facts point to the males first reaching maturity when four years of age and the females when five years.

III. Food.

In carrying on the investigations on board the trawling vessels many anglers were opened and the contents of their stomachs observed, and I have tabulated the results in the Tables appended. Fish, of course, is almost the only food upon which the angler lives, but it was desirable to ascertain the proportion of edible and inedible forms and of round-fishes and valuable flat-fishes which make up its dietary, and also, if possible, to ascertain the amount of destruction caused by this species among the food fishes.

It is obvious from its structure that the angler even in the young stage is eminently piscivorous. The gape is very large compared with the size of the fish. In one fifteen-and-a-half inches long the width of the mouth was four inches, and when opened its vertical diameter was $2\frac{3}{4}$ inches; in one measuring forty-three inches the width of the mouth when open was nine inches, and the vertical diameter eight inches; in one of $51\frac{1}{2}$ inches the width of the open mouth was nine-and-three-quarter inches, and the vertical diameter nine inches. Such an aperture is obviously capable of taking in a very large fish, or numbers of small fish together. In point of fact, however, few cases were found in which large fishes had been swallowed. The largest found were codling, three of which measured 23, 20, and 20 inches respectively; one of the latter was swallowed by an angler very little longer, viz. twenty-six inches. The fish containing the others were not measured, but the stomachs which were brought ashore were very large, and belonged to large anglers. In reality, most of the fishes obtained were small, the largest angler not disdaining to snap up trifling fishes that come within reach. One of twenty-six inches, for instance, had swallowed a sprat and a small whiting.

In the following Table I have tabulated the results of the examination of the stomachs of 541 anglers of various sizes, caught mostly in the Moray Firth, Aberdeen Bay, and the deep water off the Shetlands. Of these, 261, or 48·2 per cent., were found to be empty, and in many instances the stomach was shrunken and collapsed, with thick walls, probably showing that a considerable interval had elapsed since a meal had been obtained. Of the remaining 280, fish, or traces of fish, were found in 269, cephalopods alone in ten, and a shore-crab *(Carcinus)* alone in another. In 69 of those containing fish the contents of the stomach were pulp, of more or less fluid consistence, in which fragments of fish or fish-bones were discovered, and in eighteen instances the fish were less digested, but indistinguishable as round or flat fish by ordinary means, and they are described as "fish-remains." Of the remainder, 137 were round-fishes and 58 flat-fishes, but a proportion in each case were too far digested to enable identification of the species to be made, viz. thirty-eight round-fishes and twenty-one flat-fishes.

Thus, of the fish that could be distinguished, 70·3 per cent. of the stomachs contained round-fishes and 29·6 per cent. flat-fishes. Among the round-fishes, six, or 4·4 per cent., were codlings; eighteen, or 13·1 per cent., were haddocks; thirty-four, or 24·8 per cent., were whitings; three, or 2·2 per cent. were gurnards; eight, or 5·8 per cent., were herrings; two, or 1·5 per cent., were sprats; twenty, or 14·6 per cent., were sand-eels; three, or 2·2 per cent., pogges (*Agonus*); one, or 0·7 per

	No. Examined.	Empty.	Fish Pulp.	Fish Remains.	Round Fishes.															Flat Fishes.								Starry Ray.	Cephalopods.	Crustacea.
					Unidentified.	Codling.	Haddock.	Whiting.	Gurnard.	Herring.	Sprat.	Sand-eel.	Pogge.	Lesser Weever.	Norway Pout.	Lumpenus.	Total.	Unidentified.	Plaice.	Common Dab.	Solenette.	Long Rough Dab.	Witch.	Flounder.	Total.					
I. Moray Firth—																														
January,	7	6	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...
June,	19	17	1	...	...	...	...	...	1	...	...	...	...	...	...	...	2	2	1	1	...	...	...	...	12	...	...	...	6	1
July,	33	16	4	...	1	...	...	...	...	1	...	...	...	...	...	...	2	5	2	2	...	...	...	1	8	...	...	...	...	...
August,	84	55	7	3	1	...	...	...	...	...	...	...	...	...	...	...	2	1	...	1	...	...	...	...	2	...	...	...	...	...
September,	9	6	...	1	1	...	...	...	...	...	...	6	...	...	...	...	25	1	1	3	...	...	...	...	4	...	...	...	5	1
November,	35	29	25	5	11	...	2	5	1	...	2	...	...	...	...	...	11	1	...	1	...	...	...	...	2	...	...	...	...	...
December,	40	23	7	...	...	...	1	5	...	3	...	...	...	...	...	...	44	10	1	10	7	...	...	1	29	...	...	...	11	2
Total,	277	152	43	8	15	...	3	11	2	4	2	6	1	...	...	...	46	7	1	6	...	...	...	2	16	...	...	...	1	...
II. Aberdeen Bay—																														
January,	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May,	3	1	1	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...
June,	12	4	1	...	1	...	2	1	...	...	...	...	...	...	...	...	4	...	...	4	...	...	...	...	4	...	...	...	...	...
July,	54	21	3	3	2	...	2	2	...	...	...	14	1	1	...	...	22	6	...	1	...	...	...	2	10	...	...	...	...	...
September,	8	2	...	...	2	...	1	3	...	...	...	...	...	...	...	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...
October,	10	...	2	...	1	...	1	5	...	...	...	...	...	...	...	...	7	1	...	1	...	...	...	...	2	...	...	...	1	...
November,	16	10	...	...	2	...	...	3	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...
December,	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...
Total,	105	39	5	5	8	...	6	15	...	...	...	14	2	1	...	...	46	7	1	6	...	...	...	2	16	...	...	...	1	...

	No. Examined.	Empty.	Fish Pulp.	Fish Remains.	Round Fishes.												Flat Fishes.								Starry Ray.	Cephalopods.	Crustacea.
					Unidentified.	Codling.	Haddock.	Whiting.	Gurnard.	Herring.	Sprat.	Sand-eel.	Pogge.	Lesser Weever.	Norway Pout.	Lumpenus.	Total.	Unidentified.	Plaice.	Common Dab.	Solenette.	Long Rough Dab.	Witch.	Flounder.	Total.			
III. Dog Hole off Aberdeen—																											
June,	1	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...
August,	1	1	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
September,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...
November,	6	1	2	...	1	1	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	1	...	...	1	...	...	...
December,	3	2	...	...	1	...	...	1	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...
Total,	12	4	2	...	2	1	...	1	...	...	...	...	...	...	...	...	4	1	...	...	...	2	...	...	3	...	...	...
IV. Thirty Miles E.S.E. of Aberdeen—																											
November,	13	7	...	...	1	4	1	2	...	...	...	...	...	...	...	...	8	...	...	...	...	...	...	...	...	...	...	...
V. Forth—																											
July,	12	8	...	...	2	...	...	...	...	...	...	...	...	...	...	1	3	...	...	...	...	2	...	...	2	...	...	...
VI. Deep Water off Shetlands—																											
May,	47	20	16	...	5	...	...	...	...	...	...	...	...	...	1	...	6	2	...	2	...	1	...	...	5	...	...	...
September,	22	9	...	1	1	...	4	1	...	4	...	...	...	...	...	1	11	...	...	...	...	1	...	...	1	...	...	...
October,	53	22	3	4	4	1	4	4	1	...	...	..	...	...	1	...	15	1	...	...	...	...	1	...	2	1	1	...
Total,	122	51	19	5	10	1	8	5	1	4	...	...	...	...	2	1	32	3	...	2	...	2	1	...	8	1	1	...
Grand Total,	541	261	69	18	38	6	18	34	3	8	2	20	3	1	2	2	137	21	2	18	7	6	1	3	58	1	13	2

cent., lesser weever; two, or 1·5 per cent., Norway pout; and two, or 1·5 per cent., *Lumpenus*. Among flat-fishes, common dabs numbered eighteen, or 31 per cent.; solenettes seven, or 12·1 per cent.; long rough dabs six, or 10·4 per cent.; plaice two, or 3·4 per cent.; flounders three, or 5·2 per cent.; and witches one, or 2 per cent. The percentage of each species of the total species identified is as follows:—

Codling.	Haddock.	Whiting.	Gurnard.	Herring.	Sprat.	Sand-eel.	Pogge.	Lesser Weever.	Norway Pout.	Lumpenus.	Plaice.	Common Dab.	Solenette.	Long Rough Dab.	Witch.	Flounder.	Starry Ray.
4·4	13·1	24·7	2·2	5·7	1·5	14·5	2·2	0·7	1·5	1·5	1·4	13·1	5·1	4·3	0·7	2·2	0·7

It thus appears that, so far as the anglers investigated are concerned, the principal food consisted of whitings, sand-eels, haddocks, and common dabs, and in smaller amount of herrings, solenettes, and others. The Table, however, shows that the proportions differ on the different grounds, and at different seasons. In Aberdeen Bay and the Moray Firth whitings and common dabs formed the staple diet, and then haddocks; no codlings were distinguished in the 382 stomachs from these localities. In the deep water off the Shetlands haddocks appear to form a more important constituent than whitings, and among flat-fishes common dabs and long rough dabs. On the offshore grounds, also, codlings enter more largely into the diet of the angler.

The proportion of sand-eels, herrings, and solenettes is surprisingly large. Herrings were got in three months, July, September, and December, and it is probable from the abundance of this fish at the bottom at certain times that it forms a fair proportion of the food of the angler. Sand-eels were got only in two months, namely in July in Aberdeen Bay and in November in the Moray Firth. It forms a larger part of the food of predaceous fishes than might be expected. The number found in single stomachs of anglers varied from one or two to twenty-three. The solenette was only procured in the stomachs of anglers taken in the Moray Firth in July, when they seem to be abundant in the inshore waters there. Its small size enables it to escape from the trawl-net as a rule, but it is occasionally taken, and more commonly in August than in July. The presence of *Lumpenus*, found in the stomachs of an angler from the Forth in July and another from the deep water in September, probably indicates a greater abundance of this form than is commonly supposed. In both cases the anglers were small, viz. nine inches and nine-and-a-half inches; one had two, and the *Lumpenus* measured $8\frac{1}{2}$, $8\frac{3}{4}$, and $9\frac{1}{2}$ inches long, or about as long as the anglers. The small anglers, indeed, capture fishes sometimes of considerable size. Thus, one a little over six inches had swallowed a round-fish $4\frac{3}{4}$ inches long; one of seven inches a haddock of six-and-a-half inches; one of eight-and-a-half inches a round-fish of six-and-three-quarter inches; and other small anglers had gulped flat-fishes of four inches. At stages much younger than any observed they must evidently be capable of swallowing fishes of a size proportionally large compared with their own. The young anglers got off Caithness had been feeding on sand-eels. One angler of eleven-and-three-quarter inches had twenty-three in its stomach.

I have already stated that the great majority of the fishes found in the

stomachs were small, even when the angler was large. The codlings ranged from nine to twenty-three inches; the whitings were mostly small, from four inches upwards, but occasionally measuring ten, eleven, twelve, and fourteen inches. The haddocks, on the other hand, were mostly medium-sized, ranging from six-and-a-half to fifteen-and-a-half inches, but generally measuring from ten to fourteen inches. Whether this difference indicates a difference in the habit, or habitat, of the young haddock is not clear. Possibly the whiting, which is predaceous, darts about in pursuit of other fishes and thus comes within reach of the angler more often than the leisurely-feeding haddock. The flat-fishes were also, as a rule, small, the common dabs measuring from three-and-a-half to six-and-a-half inches, and the long rough dabs between four and five inches. In no case were large flat-fishes obtained in the stomachs. Small plaice were got in two only—viz., two in July in one caught in the Moray Firth, and six, along with three flounders, also in July in Aberdeen Bay. The witch from the deep-sea grounds measured ten inches. The rarity of the large fishes in the stomach of the angler probably points to their greater caution than when younger. Experience no doubt teaches them more readily to detect and to avoid the formidable lurking trap which forms part of their natural environment.

The only other organisms besides fish which were found in the stomachs were a shore-crab in one and a swimming-crab in another, and cephalopods in thirteen. The latter, having the habit of crawling about the bottom, appear to constitute a fair proportion of the angler's food in autumn. In all cases but one the cepalopods were squids; the other was an *Eledone*. The body of the cephalopod is digested much more rapidly than the head and tentacles.

In the stomachs of 102 anglers taken by the "Garland" in the Forth some years ago, fifty-one contained food and fifty-one were empty. Whitings were got in six, sand-eels in four, herring in three, haddock in three, cod in one, rockling in one, *Lumpenus* in one, skate in two, plaice in one, long rough dab in one, and lemon dab in one, while cephalopods were found in two and crustacea (*Eupagurus*, *Nephrops*) in three.*

During the Irish Survey Holt found seven stomachs of anglers containing food, the identified forms being sprats, common dab, witch, and sole.†

* *Seventh—Tenth Annual Reports, Part III.*
† *Report to Council, Roy. Dub. Soc.*, 1891, p. 311.

TABLE I.—THE PARTICULARS OF THE FOOD OF THE ANGLER.

Date.	Place.	Depth.	Length.		Contents of Stomach.
		Fms.	Cm.	In.	
1901.	I. MORAY FIRTH.				
17 Jan.	Off Dunbeath -	18 to 25	72·6	28½	Empty.
,,	,,	,,	94·2	37	,,
,,	,,	,,	70·1	27¾	,,
18 Jan.	,,	,,	103·7	40¾	,,
,,	,,	,,	71·3	28	Two small Whiting.
,,	,,	,,	78·2	30¾	Empty.
,,	,,	,,	49·6	19½	,,
1 June	Off Lossiemouth -	12 to 16	72·6	28½	,,
,,	,,	,,	70·0	27½	,,
,,	,,	,,	77·0	30¼	,,
,,	,,	,,	63·1	24¾	,,
,,	,,	,,	74·0	29	,,
,,	,,	,,	38·7	15¼	,,
,,	,,	,,	40·1	15¾	Common Dab, about 85 mm.
,,	Burghead Bay -	5 to 14	65·6	25¾	Bone of large round-fish.
,,	,,	,,	58·6	23	Empty.
,,	,,	,,	75·1	29½	,,
,,	,,	,,	60·6	23¾	,,
,,	,,	,,	61·2	24	,,
,,	,,	,,	39·4	15½	,,
,,	,,	,,	35·7	14	,,
,,	,,	,,	39·4	15½	,,
,,	,,	,,	29·3	11½	,,
,,	,,	,,	33·6	13¼	,,
,,	,,	,,	19·0	7½	,,
4 June	Sinclair's Bay -	,,	28·8	11¼	,,
1 July	Burghead Bay -	8 to 11	58·0	22¾	Fish pulp.
,,	,,	,,	59·5	23½	One Common Dab, 190 mm.
,,	,,	,,	47·5	18¾	Empty.
,,	,,	,,	41·0	16	,,
,,	,,	,,	38·8	15¼	,,
,,	,,	,,	35·8	14	,,
,,	,,	,,	28·0	11	,,

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	MORAY FIRTH—*continued.*				
1 July	Burghead Bay -	8 to 11	72·3	28½	Empty.
,,	,,	,,	67·3	26½	2 small, partly digested, Plaice.
,,	,,	,,	34·8	13¾	Empty.
,,	,,	,,	45·7	18	,,
,,	,,	,,	40·0	15¾	,,
,,	,,	,,	39·2	15½	Fish pulp.
,,	,,	,,	42·5	16¾	Empty.
,,	,,	,,	35·9	14¼	A little fish pulp.
,,	,,	,,	29·1	11½	Empty.
,,	,,	,,	23·4	9¼	Solenette, 115 mm.
,,	,,	,,	19·8	7¾	A little fish pulp.
,,	,,	,,	44·5	17½	Digested round-fish.
,,	,,	,,	47·5	18¾	Empty.
,,	,,	,,	43·3	17	,,
,,	,,	,,	38·0	15	,,
,,	,,	,,	22·4	8¾	One digested Common Dab.
2 July	Brorapoint, N.E. Dunrobin	10	81·9	32¼	Empty.
3 July	Off Dunrobin - -	,,	28·0	11	One Gurnard, 132 mm.; One Solenette, 80 mm.
,,	,,	,,	19·8	7¾	½ digested small flat-fish (?) Solenette.
,,	,,	,,	23·8	9½	Two half digested flat-fishes.
,,	,,	,,	21·8	8½	Three Solenettes.
,,	,,	10 to 12	23·0	9	Two Solenettes.
,,	,,	,,	24·8	9¾	Three Solenettes.
,,	,,	,,	22·0	8¾	Two Herring & two Solenettes.
,,	,,	6½ to 12	27·7	11	One Solenette.
,,	,,	,,	20·8	8¾	Empty.
2 Aug.	Burghead Bay -	5½ to 15	67·5	26½	
,,	,,	,,	54·2	21½	,,
,,	,,	,,	60·5	23¾	,,
,,	,,	,,	43·0	17	Fish pulp.
,,	,,	,,	47·0	18½	One Squid.
,,	,,	,,	47·5	18¾	,,

Table I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	Moray Firth—*continued.*				
2 Aug.	Burghead Bay	5½ to 15	44·5	17½	One Dab.
,,	,,	,,	43·5	17	Empty.
,,	,,	,,	39·0	15¼	,,
,,	,,	,,	40·0	15¾	,,
,,	,,	,,	37·5	14¾	,,
,,	,,	,,	41·0	16	,,
,,	,,	,,	38·0	15	,,
,,	,,	,,	30·0	11¾	One small fish, digested.
,,	,,	,,	27·5	10⅞	Empty.
,,	,,	,,	26·0	10¼	Fish Pulp.
,,	,,	,,	28·0	11	Empty.
,,	,,	,,	25·0	10	,,
,,	,,	,,	23·0	9	,,
,,	,,	5 to 25	87·2	34¼	,,
,,	,,	,,	65·6	25¾	,,
,,	,,	,,	63·1	24¾	,,
,,	,,	,,	38·5	15¼	,,
,,	,,	,,	29·5	11¾	Small piece of flat-fish.
,,	,,	,,	26·0	10¼	Empty.
,,	,,	,,	24·8	9¾	Pogge, 76 mm.
,,	,,	,,	23·4	9¼	Empty.
,,	,,	,,	23·8	9¼	,,
,,	,,	,,	36·0	10¼	One Squid.
,,	,,	,,	25·0	10	Empty.
,,	,,	,,	22·3	8¾	,,
,,	,,	,,	65·0	25½	,,
,,	,,	,,	44·0	17½	Fish remains.
,,	,,	,,	42·6	16¾	Empty.
,,	,,	,,	40·3	15¾	,,
,,	,,	,,	41·8	16½	,,
,,	,,	,,	42·6	16¾	,,
,,	,,	,,	31·5	12½	,,

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	MORAY FIRTH—*continued.*				
2 Aug.	Burghead Bay	5 to 25	28·5	11¼	Empty.
,,	,,	,,	26·8	10½	,,
,,	,,	,,	24·8	9¾	,,
,,	,,	,,	25·2	10	,,
,,	,,	,,	25·0	9⅞	,,
3 Aug.	,,	,,	61·0	24	One large Squid.
,,	,,	,,	58·0	22¾	One large, much digested, round-fish.
,,	,,	,,	44·5	17½	Empty.
,,	,,	,,	41·8	16½	,,
,,	,,	,,	41·2	16¼	,,
,,	,,	,,	43·0	17	,,
,,	,,	,,	41·4	16⅓	One Squid.
,,	,,	,,	37·8	14¾	Some fish pulp.
,,	,,	,,	42·5	16¾	Empty.
,,	,,	,,	41·8	16½	One Squid.
,,	,,	,,	43·0	17	Empty.
,,	,,	,,	32·2	12¾	,,
,,	,,	,,	29·0	11½	,,
,,	,,	,,	28·2	11	,,
,,	,,	,,	25·0	9⅞	One Common Dab, 120 mm.
,,	,,	,,	22·6	9	Empty.
,,	,,	,,	22·5	8⅞	Fish pulp.
,,	,,	,,	22·6	8⅞	Piece of flat-fish.
,,	,,	,,	21·8	8⅝	Empty.
,,	,,	,,	21·0	8¼	,,
,,	Dornoch Firth, off Dunrobin	5 to 11	35·5	14	,,
,,	,,	,,	36·4	14¼	One Flounder, 143 mm.
5 Aug.	,,	,,	33·3	13	Empty.
,,	,,	,,	29·4	11⅝	Lot of fish pulp.
,,	,,	,,	25·2	10	Empty.
,,	,,	,,	25·6	10	Piece of flat-fish.
5-6 Aug.	,,	,,	33·2	13	Empty.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length.		Contents of Stomach.
			Cm.	In.	
1901.	MORAY FIRTH—*continued.*				
5–6 Aug.	Dornoch Firth, off Dunrobin	5 to 11	49·5	19½	Fish remains.
,,	,,	,,	42·8	16¾	Empty.
,,	,,	,,	33·5	13¼	,,
,,	,,	,,	27·3	10¾	Digested flat-fish.
,,	,,	,,	22·3	8¾	Some fish pulp.
,,	,,	,,	21·0	8¼	Empty.
6 Aug.	,,	,,	48·0	19	,,
,,	,,	,,	65·0	25½	Small Shore Crab.
,,	,,	,,	46·0	18	Fish pulp.
,,	,,	,,	33·0	13	Remains of small flat-fish.
,,	,,	,,	36·2	14¼	Empty.
,,	,,	,,	35·0	13¾	,,
,,	,,	,,	25·5	10	Fish remains.
,,	,,	,,	25·3	10	Empty.
7 Sept.	Burghead Bay -	7	37·8	14¾	,,
,,	,,	,,	39·8	15¾	,,
,,	,,	,,	37·3	14¾	,,
,,	,,	,,	26·8	10½	,,
,,	,,	5½ to 8	38·7	15¼	One Common Dab, 195 mm.
,,	,,	,,	22·4	8⅞	Empty.
,,	,,	,,	32·6	12¾	Remains, ¾ digested, of a flat-fish.
,,	,,	,,	28·0	11	Remains of a round-fish and fish pulp.
,,	,,	,,	29·6	11⅝	Empty.
3 Nov.	30 miles west of Kinnaird Head, about 12 miles off land	50	62·3	24½	,,
	,,	,,	85·4	33¾	Bones of one round-fish.
,,	,,	,,	64·4	25½	Fish pulp and one small round-fish about 5 inches.
,,	,,	,,	69·6	27·1	Empty.
,,	,,	,,	48·4	19	,,
,,	,,	,,	38·7	15¼	,,
,,	,,	,,	109·5	43	,,
,,	,,	,,	130·0	51	,,

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	MORAY FIRTH—*continued.*				
3 Nov.	30 miles west of Kinnaird Head, about 12 miles off land	50	104·5	41¼	Empty.
,,	,,	,,	88·0	34¾	One beak of a Cuttle and the backbone of a small fish.
,,	,,	,,	107·4	–	Head and tentacles of a small Cephalopod and a small fish.
,,	,,	,,	92·2	42¼	One small Haddock, 159 mm., and the remains of a Hag fish or Lamprey, 330 mm.
,,	,,	,,	61·6	24¼	A fragment of fish bone.
,,	,,	,,	71·8	28¼	A few bones of a small round-fish.
,,	,,	,,	58·5	23	Fish pulp, two small round-fish 6 or 7 inches, partially digested, and the remains of a smaller one.
,,	,,	,,	70·0	27½	Remains of one or two round-fish.
,,	,,	,,	81·6	32	Whiting, 131 mm., quite perfect.
,,	,,	,,	70·2	27¾	Whiting, 141 mm.
,,	,,	,,	61·0	24	Remains of one small round-fish.
,,	,,	,,	54·6	21½	Fish pulp and fragments of round-fish.
,,	,,	,,	56·0	22	Fish pulp, two round-fish, one about 305 mm., but greatly digested.
,,	,,	,,	30·5	12	Empty.
,,	,,	,,	29·8	11¾	,,
,,	Off Lossiemouth -	11 to 15	87·5	34½	Fish remains.
,,	,,	,,	56·0	22	One Squid, about 5 inches long.
,,	,,	,,	45·7	18	Two round-fishes, partly digested, 5–6 inches long.
,,	,,	,,	64·8	25½	Empty.
,,	,,	,,	57·5	22¾	,,
5 Nov.	,,	,,	30·9	12	Remains of a flat-fish.
,,	,,	,,	24·6	9¾	One Common Dab, half digested, 6 inches long.
,,	,,	,,	34·6	13½	Remains of a small round-fish, about 3½ inches.
,,	Dornoch Firth -	10	55·1	21¾	One Common Dab, partly digested, 6 inches.
,,	,,	,,	36·5	14¼	Empty.
,,	,,	,,	20·4	8	,,
,,	,,	,,	18·3	7¼	Fish remains.
,,	,,	,,	16·3	6½	Whiting, partly digested, about 4 inches long.
,,	,,	,,	20·7	8⅛	Empty.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length.		Contents of Stomach.
			Cm.	In.	
1901.	MORAY FIRTH—*continued.*				
5 Nov.	Dornoch Firth -	10	92·8	36½	Empty.
,,	,,	,,	62·0	24½	Fish pulp.
8 Nov.	Near Smith's Bank	35	32·7	13	Empty.
,,	,,	,,	36·4	14¼	One Gurnard, about 6 inches.
,,	Smith's Bank - -	26	70·0	27½	Remains of a Haddock, about 400 mm.
,,	Off Lybster - -	23 to 34	14·9	5⅞	Fish pulp.
,,	,,	,,	20·1	8	,,
,,	,,	,,	17·7	7	,,
,,	,,	,,	19·8	7¾	,,
,,	,,	,,	15·4	6	,,
,,	,,	,,	15·5	6	,,
,,	,,	,,	13·4	5¼	,,
,,	,,	,,	17·5	6⅞	,,
,,	,,	,,	14·8	5¾	,,
,,	,,	,,	15·3	6	,,
,,	,,	,,	14·8	5¾	Sand-eels.
,,	,,	,,	14·7	5¾	
,,	,,	,,	13·0	5⅛	,,
,,	,,	,,	14·9	5⅞	,,
,,	,,	,,	14·0	5½	,,
,,	,,	,,	14·5	5¾	Empty.
,,	,,	,,	15·6	6⅛	,,
,,	,,	,,	13·9	5½	,,
,,	,,	,,	16·5	6½	,,
,,	,,	,,	27·7	10⅞	,,
,,	,,	,,	14·2	5⅞	,,
,,	,,	,,	18·0	7⅛	,,
,,	,,	,,	92·0	36¼	,,
,,	,,	,,	80·0	31½	Squid.
,,	,,	,,	46·0	18¼	Fish pulp.
,,	,,	,,	79·0	31	Empty.
,,	,,	,,	29·8	11¾	Fish pulp.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	MORAY FIRTH—*continued.*				
Nov.	Off Lybster - -	23 to 34	16·8	$6\frac{5}{8}$	Fish pulp.
,,	,,	,,	14·7	$4\frac{3}{4}$	,,
,,	,,	,,	32·3	$12\frac{3}{4}$	,,
,,	,,	,,	16·1	$6\frac{3}{8}$	,,
,,	,,	,,	14·8	$5\frac{7}{8}$	,,
,,	,,	,,	13·6	$5\frac{3}{8}$	,,
,,	,,	,,	12·8	5	,,
,,	,,	,,	16·8	$6\frac{5}{8}$	Sand-eel.
,,	,,	,,	32·5	$12\frac{3}{4}$	Empty.
,,	Off Golspie - -	7 to 10	70·0	$27\frac{1}{2}$	Common Dab.
,,	,,	,,	45·5	18	Empty.
,,	,,	,,	40·2	$15\frac{3}{4}$	Fish pulp.
9 Nov.	Dornoch Firth -	,,	63·5	25	Empty.
,,	,,	,,	63·0	$24\frac{3}{4}$	,,
,,	,,	,,	35·8	14	Fish pulp.
,,	,,	,,	27·3	$10\frac{3}{4}$	,,
10 Nov.	,,	,,	21·4	$8\frac{1}{2}$	,,
,,	,,	,,	88·0	$34\frac{3}{4}$	Empty.
,,	,,	,,	32·5	$12\frac{3}{4}$	Two small Whiting.
,,	,,	,,	36·1	$14\frac{3}{4}$	Whiting and a swimming Crab.
11 Nov.	,,	,,	109·4	43	Squid.
,,	,,	,,	27·5	$10\frac{3}{4}$	Fish pulp.
,,	,,	,,	36·0	$14\frac{3}{4}$	Empty.
20 Dec.	Burghead Bay -	7 to 24	31·8	$12\frac{1}{2}$	,,
,,	,,	,,	45·0	$17\frac{3}{4}$	Flat-fish remains.
,,	,,	,,	40·3	$15\frac{3}{4}$	Empty.
,,	,,	,,	48·2	19	,,
,,	,,	,,	33·0	13	,,
,,		,,	37·2	$14\frac{3}{4}$	,,
,,	,,	,,	35·9	$14\frac{1}{4}$	Remains of Haddock.
,,	,,	,,	43·1	17	Empty.
,,	,,	,,	37·6	$14\frac{3}{4}$	Fish pulp.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length.		Contents of Stomach.
			Cm.	In.	
1901.	MORAY FIRTH—*continued.*				
20 Dec.	Burghead Bay -	7 to 24	31·5	12½	Empty.
,,	,,	,,	25·4	10	Fish pulp.
,,	,,	,,	30·4	12	,,
,,	,,	,,	65·0	25½	One small Herring.
,,	,,	7 to 15	59·9	23½	Sprat and small Whiting.
,,	,,	,,	92·2	36¼	Empty.
,,	,,	,,	70·1	27½	,,
,,	,,	,,	66·3	26	,,
,,	,,	,,	100·6	39½	,,
,,	,,	,,	76·5	30	Sprat and Whiting.
,,	,,	,,	71·4	28	Fish pulp.
,,	,,	,,	96·6	38	Empty.
,,	,,	,,	68·8	27	Whiting and fish pulp.
,,	,,	,,	65·0	25½	Empty.
,,	,,	,,	73·3	28¾	,,
,,	,,	,,	57·4	22½	Large Herring.
,,	,,	,,	44·5	17½	,,
,,	,,	,,	42·0	16½	Fish pulp.
,,	,,	,,	48·3	19	,,
,,	,,	,,	39·4	15½	Empty.
,,	,,	,,	70·1	27½	,,
24 Dec.	,,	11	72·0	28¼	Fish pulp.
,,	,,	,,	77·1	30¼	Empty.
,,	,,	,,	75·1	29½	,,
,,	,,	,,	64·4	25¼	One small Common Dab, and small Whiting.
,,	,,	,,	77·7	30½	Empty.
,,	,,	,,	68·8	27	,,
,,	,,	,,	65·0	25½	One small Whiting.
,,	,,	,,	53·5	21	Empty.
,,	,,	,,	52·7	20¾	,,
	II. ABERDEEN BAY.				
15 Jan.	Off Black Dog -	7 to 16	21·2	8⅜	Empty.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	ABERDEEN BAY—*continued.*				
30 May	Off Collieston	9 to 14	34·1	13½	Empty.
,	,,	,,	34·5	13½	Fish pulp.
,	,,	,,	19·0	7½	Pogge, about 85 mm.
6 June	Off Stirling Quarries	12 to 16	41·1	16¼	Empty.
,,	,,	,,	37·1	14½	,,
,,	,,	,,	29·3	11½	Fish pulp.
,,	,,	,,	20·0	7⅞	Empty.
,,	,,	,,	33·1	13	Common Dab, 85 mm.
,,	,,	,,	39·8	15¾	,, 103 mm.
,,	,,	,,	78·6	30¾	Remains of large Haddock, 180 mm.
,,	,,	,,	67·6	26½	Common Dab, 165 mm.
7 June	,,	,,	63·8	25	Haddock, 270 mm.
,,	,,	,,	31·9	12½	3 small Whiting.
29 June	Off Black Dog -	8	28·8	11⅜	One small Common Dab and one small round-fish.
,,	,,	,,	20·8	8¼	Empty.
4 July	Cruden Scars to Black Dog	5½ to 20	68·7	27	,,
,,	,,	,,	56·0	22	,,
,,	,,	,,	44·5	17½	Digested flat-fish.
,,	,,	,,	34·8	13¾	Fish pulp.
,,	,,	,,	35·8	14	Empty.
,,	,,	,,	22·0	8¾	,,
5 July	,,	8 to 15	71·2	28	Digested round-fish.
,,	,,	,,	40·0	15¾	Empty.
,,	,,	,,	39·8	15¾	Two digested Sand-eels.
,,	,,	,,	36·8	14½	One Haddock, 230 mm.
,,	,,	,,	37·3	14¾	Empty.
,,	,,	,,	26·3	10⅜	Three digested Sand-eels.
,,	,,	,,	27·4	10¾	One ,, ,,
,,	,,	,,	19·5	7¾	Empty.
,,	Off Collieston -	10	29·0	11½	Pogge.
,,	,,	,,	49·0	19¼	Digested round-fish.
,,	,,	,,	36·4	14¼	Empty.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	ABERDEEN BAY—*continued.*				
5 July	Off Collieston -	10	28·0	11	Digested flat-fish.
,,	,,	,,	54·4	21½	One Haddock, 222 mm, and fish remains.
,,	,,	,,	24·2	9½	Empty.
30 July	Off Newburgh -	6 to 10	23·6	9¼	,,
,,	,,	,,	26·9	10⅝	,,
,,	,,	,,	26·6	10¼	,,
,,	,,	,,	44·5	10⅛	,,
,,	,,	,,	25·8	10⅛	Fish pulp.
,,	,,	,,	27·4	10⅜	Common Dab, 125 mm.
,,	,,	,,	28·0	11	Remains of flat-fish.
,,	,,	,,	24·3	9⅝	Empty.
,,	,,	,,	43·6	–	,,
,,	,,	,,	29·7	11¾	,,
,,	,,	,,	40·5	16	,,
,,	,,	,,	24·2	9½	,,
,,	,,	,,	41·3	16¼	,,
,,	,,	,,	24·9	9¾	Fish pulp.
,,	,,	,,	35·0	13¾	Three or four Sand-eels, one Weaver, 140 mm., and the remains of a flat-fish.
,,	,,	,,	26·9	10½	Empty.
,,	,,	,,	26·3	10⅜	Several Sand-eels (5 or 6).
,,	,,	,,	24·9	9¾	Three small Sand-eels.
,,	,,	,,	41·8	16½	Fish remains.
,,	,,	,,	62·2	24½	Six Plaice, three Flounders.
,,	,,	,,	46·3	18¼	Empty.
,,	,,	,,	42·8	16¾	Remains of two or three flat-fish.
,,	,,	,,	39·6	15½	Sand-eels.
,,	,,	,,	29·2	11½	Fish remains.
,,	,,	,,	40·0	15¾	One Flounder.
,,	,,	,,	32·9	13	Sand-eels (about six).
,,	,,	,,	29·8	11¾	23 Sand-eels, from 140 mm.
,,	,,	,,	30·6	12	One Whiting, 175 mm., and two Sand-eels.
,,	,,	,,	29·6	11¾	Fish remains.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.	ABERDEEN BAY—*continued.*				
30 July	Off Newburgh -	6 to 10	28·2	11⅛	11 Sand-eels.
,,	,,	,,	25·4	10	Four Sand-eels.
,,	,,	,,	24·9	9¾	Seven Sand-eels.
,,	,,	,,	20·9	8¼	Three Sand-eels and one small flat.
31 July	Opposite Ythan -	11 to 13	71·2	28	One Whiting, about 312 mm.
4 Sept.	Off Collieston -	8 and 9	43·2	17	Fish remains, ¾ digested, and a Whiting, 190 mm.
,,	,,	,,	30·8	12	Fish remains and a Whiting.
,,	,,	,,	33·6	13¼	Remains of a round-fish.
,,	,,	,,	23·2	9⅛	Empty.
,,	Off Newburgh -	10	29·1	11½	One half-digested round-fish.
,,	,,	,,	73·8	29	A Haddock, 302 mm., and the remains of several others.
,,	,,	,,	29·8	11¾	Empty.
,,	,,	,,	31·2	12¼	A small Whiting, 110 mm.
1900.					
9 Oct.	,,	16	28·4	11¼	Two young Whitings, considerably digested.
23 Oct.	,,	36 to 49	76·7	30	Tentacles and head of an *Eledone*; body completely digested.
31 Oct.	,,	15	38·0	15	One partly digested Whiting and remains of three round and one flat-fish.
,,	,,	10	33·2	13	Three round-fishes; a Whiting about five inches long was half digested and the others more digested.
,,	,,	,,	79·6	31¼	One Haddock, 313 mm., just swallowed.
,,	,,	,,	32·3	12¾	A small quantity of fish remains.
,,	,,	,,	36·3	14¼	Two Whitings, 143 mm. and 128 mm., and remains of a round-fish.
,,	,,	,,	36·0	14¼	Remains of several round-fishes; one Whiting.
,,	,,	,,	36·9	14½	Fish remains.
,,	,,	,,	30·0	11¾	One Common Dab, 113 mm., and remains of two round-fish; probably Whitings.
5 Nov.	Opposite Newburgh	7 to 20	4·35	17	Pulp of a round-fish.
,,	,,	,,	31·0	12¼	One Whiting, about 127 mm.
,,	,,	,,	31·7	12½	Empty.
,,	,,	,,	30·8	12	,,
,,	,,	,,	24·2	9½	,,
,,	,,	,,	19·7	7¾	Pulp of a round-fish.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1900.	ABERDEEN BAY—*continued.*				
5 Nov.	Opposite Newburgh	7 to 20	27·1	10¾	Empty.
,,	,,	,,	38·0	15	Whiting (2).
6 Nov.	Off Newburgh -	8 to 13	36·8	14½	A little fish pulp.
,,	,,	,,	28·0	11	Empty.
7 Nov.	,,	45 to 53	31·5	12½	,,
9 Nov.	,,	15½	30·4	12	,,
,,	,,	,,	18·7	7⅜	Remains of one Whiting, about 5 inches.
,,	,,	,,	35·5	14	Empty.
29 Nov.	Off Belhelvie - -	13 to 15	115·7	45½	,,
,,	,,	,,	30·7	12	,,
17 Dec.	Off Black Dog -	9	84·0	33	Seven partly digested Whitings, about five inches long.
	III. OFF ABERDEEN.				
28 June.	Dog Hole - - (Off Aberdeen.)	65	20·4	8	Flat-fish half digested, apparently Long Rough Dab.
21 Aug.	,,	58	66·2	26	Empty.
3 Sept.	,,	58	33·2	13	One Long Rough Dab.
5 Nov.	12¾ miles from Girdleness	70	69·0	27¼	One Codling, 235 mm.
,,	,,	,,	35·0	13¾	Remains of a round-fish, half digested.
,,	,,	,,	23·5	9¼	Fish pulp.
,,	,,	,,	32·8	13	Empty.
,,	,,	,,	68·4	27	One Long Rough Dab, 155 mm.
28 Nov.	9 miles from Girdleness, S.E. by E.	68	80·2	31½	Empty.
16 Dec.	,,	57	67·8	26¾	Whiting, about 145 mm, and remains of a round-fish.
,,	,,	,,	45·8	18	Empty.
,,	,,	,,	35·1	13¾	,,
19 Nov.	Off Aberdeen E.S.E.	30 to 49	66·0	26	One Codling, 20 inches, slightly digested.
,,	,,	,,	63·5	25	One Codling, 9 inches, three-parts digested.
,,	,,	,,	73·5	29	One Whiting, 11¼ inches, slightly digested.
,,	,,	,,	107·0	42	Empty and shrunken.
,,	,,	,,	71·0	28	,,
,,	,,	,,	75·0	29½	,,
,,	,,	,,	73·5	29	,,
,,	,,	,,	63·5	25	Remains of Codling.

TABLE I.—*continued.*

Date.	Place.	Depth, Fms.	Length.		Contents of Stomach.
			Cm.	In.	
1900.	OFF ABERDEEN—*continued.*				
19 Nov.	Off Aberdeen E.S.E.	30 to 42	89·0	35	Empty.
,,	,,	,,	64·7	25½	,,
,,	,,	,,	63·5	25	Remains of small round-fish, about 10 inches.
,,	,,	,,	80·0	31½	Empty.
,,	,,	,,	108·0	42½	One Codling, 15 inches, partly digested; two Haddocks. 10¼ inches and 10½; one Whiting, nine inches, slightly digested.
24 Jan.	IV. FIRTH OF FORTH	,,	24·1	9½	Two *Lumpenus*, 8¾ and 9½ inches.
,,	,,	,,	36·9	14½	Empty.
,,	,,	,,	19·7	7¾	,,
,,	,,	,,	28·5	11¼	Small Long Rough Dab, partly digested.
,,	,,	,,	16·5	6½	Empty.
,,	,,	,,	24·2	9½	,,
,,	,,	,,	22·2	8¾	,,
,,	,,	,,	31·7	12½	Remains of a small round-fish.
,,	,,	,,	28·0	11	Empty.
,,	,,	,,	26·7	10½	,,
,,	,,	,,	23·5	9¼	,,
,,	,,	,,	25·3	10	One small Long Rough Dab, and remains of a round-fish.
1901.					
15 May	Deep Water - -	75 to 78	122·1	48	Empty.
,,	,,	,,	89·2	35	,,
,,	,,	,,	60·5	23¾	,,
16 May	North of Shetland -	,,	29·5	11⅝	,,
17 May	,,	,,	88·0	34⅓	,,
19 May	,,	,,	120·0	47	,,
,,	,,	,,	31·7	12½	Common Dab, 118 mm.
,,	,,	,,	31·4	12⅜	Remains of one flat-fish
,,	,,	,,	21·5	8½	Fish pulp.
,,	,,	,,	21·6	8½	Remains of small round-fish.
,,	,,	,,	21·6	8½	Fish pulp.
20 May	,,	,,	15·5	6⅛	Remains of round-fish, about 120 mm.
,,	,,	,,	24·4	–	Empty.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.					
20 May	North of Shetland -	75 to 78	29·6	11⅝	Fish pulp.
,,	,,	,,	34·4	13½	,,
,,	,,	,,	21·8	8⅝	,,
,,	,,	,,	65·0	25½	Empty.
,,	,,	,,	62·5	24½	,,
,,	,,	,,	44·3	17½	Fish pulp.
,,	,,	,,	39·1	15½	Empty.
,,	,,	,,	34·1	13½	,,
,,	,,	,,	30·5	12	Remains of Common Dab, about 140 mm.
,,	,,	,,	31·1	12¼	Fish pulp.
,,	,,	,,	31·1	12¼	Remains of Long Rough Dab, about 125 mm.
,,	,,	,,	21·4	8½	Empty.
,,	,,	,,	21·7	8⅝	,,
,,	,,	,,	21·5	8½	Fish pulp.
,,	,,	,,	21·5	8½	,,
,,	,,	,,	23·2	9	Empty.
,,	,,	,,	17·0	6¾	,,
,,	,,	,,	16·8	6⅝	Remains of *G. esmarkii*.
21 May	,,	,,	20·7	8⅛	Empty.
,,	,,	,,	21·1	8⅜	Remains of round-fish.
,,	,,	,,	19·7	7¾	,, ,,
,,	,,	,,	19·3	7⅝	Fish pulp.
,,	,,	,,	27·9	11	Remains of flat, about 145 mm.
,,	,,	,,	33·1	13	Empty.
,,	,,	,,	21·5	8½	Fish pulp.
,,	,,	,,	18·1	7⅛	Remains of round-fish.
,,	,,	,,	18·7	7⅜	Fish pulp.
,,	,,	,,	70·7	27¾	Empty.
,,	,,	,,	77·7	30½	,,
,,	,,	,,	32·7	13	Fish pulp.
,,	,,	,,	33·1	13	Empty.
,,	,,	,,	21·7	8⅝	Fish pulp.
22 May	,,	78	18·6	7⅜	,,

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.					
22 May	North of Shetland -	78	19·4	7⅝	Fish pulp.
3 Sept.	Sixty-five miles S.S.E. of Sumburgh Head.	65	86·5	34	Five large Herrings, slightly digested.
,,	,,	,,	56·5	22¼	Empty.
,,	,,	,,	–	9½	One Long Rough Dab, 4 inches, partly digested.
,,	,,	,,	–	7	Empty.
,,	,,	,,	37·0	14½	,,
,,	,,	,,	–	7½	,,
,,	,,	,,	79·0	31	Fish remains.
,,	,,	,,	–	6½	Empty.
,,	,,	,,	–	8½	,,
,,	,,	,,	73·0	36½	One Haddock 13, and one 13½; remains of 3 or 4 round-fish, and a half digested Herring 10 inches.
,,	,,	,,	71·0	28	Remains of three or four Herrings.
,,	,,	,,	71·0	28	Remains of two or three Herrings.
,,	,,	,,	63·5	25	Empty.
,,	,,	,,	62·0	24½	Haddock, 14½ inches, slightly digested.
,,	,,	,,	–	8½	Empty.
,,	,,	,,	–	7	Whiting, 4 inches, half digested.
,,	,,	,,	–	8¾	Empty.
,,	,,	,,	–	7½	Small Haddock.
,,	,,	,,	–	9	A *Lumpenus*, 8½ inches long.
,,	,,	,,	–	7	One Haddock, 6½ inches long.
,,	,,	,,	–	8½	Remains of round-fish, 6¾ inches long.
,,	,,	,,	–	9½	Remains of Haddock.
Oct.	Eighteen to twenty-two miles S.E. of Fair Isle.	,,	65	–	One Gurnard, recently swallowed, 13¾ inches; a round-fish, nearly digested.
,,	,,	,,	–	–	One Haddock, 10½ inches, slightly digested.
,,	,,	,,	–	–	Empty; large stomach, walls shrunken and thick.
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	Half-digested Haddock, 13½ inches.
,,	,,	,,	–	–	Backbone of a small flat-fish and remains of a small Cephalopod.
,,	,,	,,	–	–	Empty; shrunken.

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length. Cm.	Length. In.	Contents of Stomach.
1901.					
Oct.	Eighteen to twenty-two miles S.E. of Fair Isle.	65	–	–	Empty; shrunken.
,,	,,	,,	–	–	One Haddock, 15¼ inches.
,,	,,	,,	–	–	Large: Fish pulp.
,,	,,	,,	–	–	Small: Whiting, 10½ inches, partly digested.
,,	,,	,,	–	–	Small: Fish pulp.
,,	,,	,,	–	–	Small: One Whiting, half-digested.
,,	,,	,,	–	–	Small: One Haddock, 14½ inches, partly digested; walls of stomach very thin and distended.
,,	,,	,,	–	–	Large: Empty, shrunken.
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	Very large: One Witch, 12 inches long, slightly digested; one Starry Ray, 5¾ inches broad, slightly digested.
,,	,,	,,	–	–	Large: One Whiting, about 14 inches.
,,	,,	,,	–	–	Medium: One Norway Pout, 7½ inches, newly swallowed.
,,	,,	,,	–	–	Large: Remains of a large round-fish, about 20 inches.
,,	,,	,,	–	–	Medium: Fish remains.
,,	,,	,,	–	–	Small: Empty.
,,	,,	,,	–	–	Moderate: Remains of a round-fish.
,,	,,	,,	–	–	Moderate: Fish remains.
,,	,,	,,	–	–	Small: Empty.
,,	,,	,,	–	–	Very large: Walls very thick.
,,	,,	,,	–	–	Small: Remains of a round-fish and pulp.
,,	,,	,,	–	–	Very small: Empty.
,,	,,	,,	–	–	Small: Empty.
,,	,,	,,	–	–	,, Fish remains.
,,	,,	,,	–	–	,, Empty.
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	Very large: Codling, about 23 inches, partly digested.
,,	,,	,,	–	–	Small: Empty.
,,	,,	,,	–	–	,, ,,

TABLE I.—*continued.*

Date.	Place.	Depth. Fms.	Length.		Contents of Stomach.
			Cm.	In.	
1901.					
Oct.	Eighteen to twenty-two miles S.E. of Fair Isle.	65	–	–	Small: Empty.
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	Moderate: Remains of round-fish.
,,	,,	,,	–	–	Moderate: One Whiting, 5¾ inches, fresh.
,,	,,	,,	–	–	Large: Empty.
,,	,,	,,	–	–	,, Fish pulp and bones.
,,	,,	,,	–	–	Small: Empty.
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	,, ,,
,,	,,	,,	–	–	Very small: Fish remains and pulp.
,,	,,	,,	–	–	Very small: Empty.

VI.—SOME FURTHER OBSERVATIONS ON THE FOOD OF FISHES, WITH A NOTE ON THE FOOD OBSERVED IN THE STOMACH OF A COMMON PORPOISE. By Thomas Scott, LL.D., F.L.S.

In my paper on the food of fishes published in Part III. of last year's Report,* I gave the results of the examination of fishes belonging to fifty-six different species. In the present paper twenty-two species are represented, sixteen of which are teleosteans and the others Rays and Dog fishes. Their names are as follow:—

Sebastes norvegicus (Ascan.).	The Norway Haddock.
Trigla gurnardus, Lin.	The Grey Gurnard.
Lampris luna (Gmelin).	The King Fish.
Anarrichichas lupus, Lin.	The Cat or Wolf-fish.
Lumpenus lampetræformis (Walbourn).	The Sharp-tailed Lumpenus.
Mugil chelo, Cuvier.	The Grey Mullet.
Labrus mixtus, Lin.	The Striped Wrasse.
Gadus luscus, Lin.	The Whiting Pout or Brassie.
„ *esmarkii*, Nilsson.	The Norway Pout.
Molua molva, Lin.	The Ling.
Onos cimbrius, Lin.	The Four-bearded Rockling.
Ammodytes tobianus, Lin.	The Lesser Sand-eel.
Drepanopsetta plattessoides (Fabr.).	The Long Rough Dab.
Pleuronectes cynoglossus, Lin.	The Witch-sole.
Argentina sphyræna, Lin.	The Hebridean Smelt.
„ *silas* (Ascanius).	The Greater Argentine.
Raia batis, Lin.	The Grey Skate.
„ *fullonica*, Lin.	The Shagreen or Fuller's Ray.
„ *radiata*, Donovan.	The Starry Ray.
„ *circularis*, Couch.	The Cuckoo or Sandy Ray.
Squalus acanthias, Lin.	The Picked Dog-fish.
Scylliorhinus canicula (Lin.).	The Lesser Spotted Dog-fish or Rough-hound.

These fishes are referred to in the sequel in the order in which they are given here.

At the end of the notes on the food of these fishes I describe the results obtained by the examination of the food found in the stomach of a common Porpoise cast ashore last year in the vicinity of the Laboratory.

Sebastes norvegicus (Ascanius).

Three *Sebastes*, measuring $11\frac{1}{4}$, $11\frac{1}{2}$, and $12\frac{1}{2}$ inches respectively, and captured in the North Sea in December 1901, had apparently been all feeding on soft animal substances (probably Annelids), for though each of their stomachs contained a quantity of food, there was nothing to show satisfactorily what it consisted of. Had it consisted of Crustaceans, shell-fish, or fish, even considerably digested, the remains of the harder parts, or some of them, would have afforded an indication of the nature of the food.

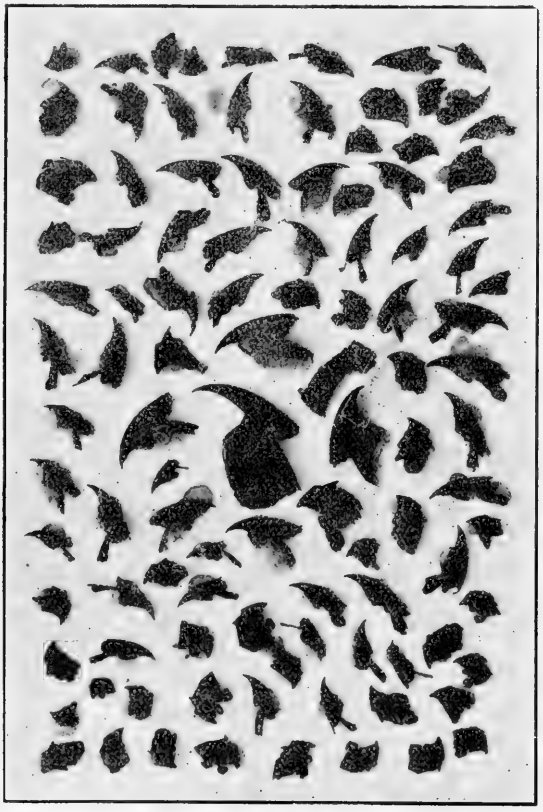
* *Twentieth Annual Report of the Fishery Board for Scotland*, Part III., p. 486.

Trigla gurnardus, Lin.

The stomachs of four Grey Gurnards were examined in March 1902. The fishes measured $10\frac{1}{8}$, $10\frac{3}{4}$, $11\frac{5}{8}$, and $11\frac{3}{4}$ inches respectively; one of the stomachs contained six specimens of *Crangon allmanni* and the remains of a young Clupeoid; another contained fragments of *Crangon* and the remains of small Clupeoids; in the stomach of the third were the remains of Crustaceans and small fishes, but too imperfect for identification; while the fourth contained nothing that could be identified.

Lampris luna (Gmelin).

A King-fish, *Lampris luna*, was captured at Shetland on October 20th, 1900, and was forwarded to the Fishery Board's Laboratory at Bay of Nigg. I had the privilege of examining the stomach of this fish, and found that it had been living exclusively and largely on Cephalopods; unfortunately none of the Cephalopods were perfect enough for identification, the soft parts being scarcely recognisable. The horny



jaws of the creatures had, however, been able to resist to a large extent the solvent action of the digestive fluids, otherwise the determination of the food would have been almost impossible. The number of Cephalopod jaws found in this stomach was 108, and, as each Cephalopod has

one pair of jaws, the number of these molluscs which had been recently captured by the King-fish would therefore amount to fifty-four. A few of the jaws were of a moderately large size, but the majority were apparently those of small specimens. Amongst the digested matter contained in this stomach were also a few things that looked like the partially-dissolved cartilaginous shells of Cuttlefishes, but they were so imperfect that no use could be made of them for the purpose of identification.* The jaws, after being mounted on a slide, were photographed by Dr. Williamson, and the accompanying figure is reproduced from the photograph.

Anarrhichas lupus, Lin.

The stomachs of eight Cat- or Wolf- fishes were examined; the sh were captured in the Moray Firth on May 16th, 1902, and were all of moderately large size. The following is a note of the contents of each of the eight stomachs:—

(1.) Fragments of a large Crab, *Cancer pagurus*, and of *Ophiura* sp.
(2.) Part of a large *Buccinum undatum*, and several large specimens of *Ophiura ciliaris*.
(3.) Fragments of several large *Solen siliqua*, the shell of a *Natica* containing a small hermit Crab, and a specimen of *Hyas coarctatus*.
(4.) Fragments of a moderately large *Cancer pagurus*, of *Solen siliqua*, and of *Cardium echinatum*, and a specimen of *Aphrodite aculeata*.
(5.) Remains of *Solen siliqua*, *Natica* sp., *Eupagurus bernhardus*, and *Hyas coarctatus*.
(6.) Fragments of *Eupagurus bernhardus*, and of several *Ophiuræ*.
(7.) Fragments of *Natica* sp., and *Venus lincta*, and of a large *Eupagurus bernhardus*. Eighty-two specimens of Star-fishes. *Ophiura ciliaris* (Linn.). Some fragments of *Echinocardium* sp. (probably *E. cordatum*). A specimen of *Aphrodite aculeata* and a fragment of a Zoophyte.
(8.) Remains of five *Natica* sp., and of *Littorina littorea*. Two *Eupagurus bernhardus*, and forty-four specimens of *Ophiura ciliaris*, all more or less complete.

Lumpenus lampetræformis (Walbaum).

The food observed in the stomach of a Sharp-tailed Lumpenus captured on the Fisher Bank consisted almost entirely of small Crustacea, the following species of which were identified:—*Leucon nasica*, *Diastylis resima*, *Bythocythere simplex*, *Macrocypris minna*, *Cytheropteron* sp., and *Robertsonia tenuis*. Two specimens of *Cyclichna nitidula*, and one or two *Operculina ammoides*, a species of Foraminifera, were also noticed. The *Lumpenus* is a fish that appears to live on or near the bottom, and it is to be expected that demersal organisms rather than pelagic will constitute the chief part of its food.

* Dr. T. Wemyss Fulton, in his "Ichthyological Notes" in Part III. of the *Nineteenth Report* of the Fishery Board for Scotland, also incidentally refers to the large number of Cephalopod mandibles observed in the stomach of the King-fish.

Mugil chelo, Cuvier.

A Grey Mullet about 14½ inches in length, captured by the salmon fishers at the Bay of Nigg on March 14th, 1902, and which was kindly handed over to the Laboratory for examination. It belonged to the same species as those obtained in the Bay last year, viz. *Mugil chelo*. There was some food in the stomach of this specimen, but it was too much digested for satisfactory identification.

Another specimen, captured on the 11th of June, had also in its stomach very little food that could be identified, the only organisms satisfactorily distinguished were one or two *Temora longicornis* and a number of specimens of the Cypris stage of *Balanus* sp.

Labrus mixtus, Lin.

A specimen 12½ inches in length was captured 15 miles north-east from Tiumpan Head, Lewis, in 70 fathoms, in May 1902, and sent to the Laboratory at the Bay of Nigg for examination. The stomach of this specimen contained nothing perfect enough for identification, but in the intestines were found the vertebræ of fishes, fragments of molluscan shells, and some small rounded stones.

Several specimens of *Clavella labracis*, v. Beneden, were obtained on the gills of this *Labrus*.

Gadus luscus, Lin.

Several specimens of the Whiting Pout, varying in length from 7¾ to 11½ inches and captured off Aberdeen in January last year, appear to have been feeding chiefly on Crustaceans. The food found in the stomach of the smallest specimen (7¾ in.) consisted of the remains of Annelids, belonging apparently to the Chætopodæ, and of fragments of Schizopoda and Amphidoda, but the only organism that could be satisfactorily identified was a male specimen of *Erichthonius hunteri* (Spence Bate). A Whiting Pout 9½ inches in length had in its stomach four small Cephalopods (*Rossia? macrosoma*, Delle Chiage), and a specimen of *Pandalus montagui*, Leach. In the stomach of another 10 inches long were the fragments of what appeared to be *Spirontocaris securifrons*, Norman. Fragments of what looked like *Schistomysis inermis* were observed in the stomach of another 10½ inches in length; while in the stomach of the largest of these Whiting Pouts were found *Crangon allmanni*, Kinahan, *Pandalus montagui*, Leach, and *Pandalina brevirostris* (Rathke)—the length of the fish was 11½ inches.

Gadus esmarkii, Nilsson.

A considerable number of Norway Pouts captured in the North Sea have been examined, but as there was a good deal of similarity in the contents of their stomachs, only a few are particularised here. Small Crustaceans were largely represented amongst the contents of their stomachs, bnt Schizopods, *Parathemisto* and pelagic Copepods were more frequently observed than other members of that group, as shown by the following sample of the fishes, which ranged in length from about 5½ to 6¾ inches.

Length of Fish.	Contents of Stomach.
inches	Numerous small Schizopods, genus and species doubtful, *Temora longicornis*, few.
5¾ ,,	Numerous small Crustaceans, which look like *Temora longicornis*, but too imperfect to be satisfactorily determined.
5¾ ,,	Several *Parathemisto oblivia*.
6 ,,	This contained nothing that could be identified.
6½ ,,	Remains of small Schizopoda and a number of *Temora longicornis*.
6¾ ,,	Numerous examples of *Parathemisto* and a minute Isopod—the male of a species belonging to the Chelifera.

Molua molva, Lin.

A number of Ling were examined, the food of which consisted chiefly of small fishes. It has been observed that the Ling, more than any other gadoid, is in the habit, when captured, of ejecting not only its food but also its stomach, turning it inside out just as one turns the finger of a glove, so that when visiting the market it is not uncommon to see Ling with their stomachs protruding from their mouths.

Onus cimbrius, Lin.

Twenty specimens of the Four-Bearded Rockling captured on the Bressay Shoal at a depth of 75 fathoms, on December 11th, 1901, were examined, and the contents of their stomachs recorded. As this species was not included amongst those in my previous paper on fish food, I give a more detailed account of the food observed in this sample from Bressay Shoal. Their sizes ranged from 6¾ to 11¾ inches, and their food, as shown in the appended tabular account, consisted chiefly of small Crustacea :—

Size of the Fish.	Contents of the Stomach.
6¾ inches.	*Pseudocuma cercaria*, *Metopa nasuta*, and some other Crustacean remains.
7¼ ,,	*Metopa nasuta* and remains of some other Crustacea.
7¼ ,,	Remains of Amphipods, but the species doubtful.
7⅝ ,,	*Metopa nasuta* and remains of other Crustacea.
7⅝ ,,	Crustacean remains, but too imperfect for identification.
8 ,,	Contents of stomach similar to the last.
8½ ,,	*Erythrops* sp., *Eudorella* sp., *Halimedon parvimanus* ; *Aceros phyllonyx* ; *Cylichna* sp.
9 ,,	*Leucon nasica* (male) and some mucus.
9 ,,	Fragments of *Calocaris macandreæ* ; *Erythrops* sp., *Leucon nasica* ; *Aceros phyllonyx* ; *Physisica marina* ; a young Dragonet, 15 mm. long.
9⅛ ,,	*Metopa nasuta* and a small lamellibranch shell.
9½ ,,	This stomach contained only a little mucus.
9⅝ ,,	Remains of two small flat fishes, and fragments of small Crustaceans.
10¼ ,,	*Metopa nasuta*, and remains of some other Crustaceans.
10¼ ,,	The food of this stomach consisted of fragments of Crustacea, but too imperfect for identification.
10¾ ,,	Fragments of *Aceros phyllonyx*, *Eudorella* sp., and Annelids.
11¼ ,,	The only food observed in this stomach consisted of the remains of Chætopod Annelids.
11½ ,,	*Campylaspis* sp. (male) ; *Halimedon parvimanus* ; *Metopa rubrovittata* and *Aceros phyllonyx*.
11½ ,,	Fragments of *Aceros phyllonyx* and the remains of some other Crustaceans.
11½ ,,	This stomach contained nothing that could be identified.
11¾ ,,	Remains of Chætopod Annelids only.

Ammodytes tobianus, Lin.

Several immature specimens of the lesser Sand-launce, captured in the North Sea and measuring from 5 to 7 inches in length, were examined, but the only organisms observed in their stomachs were one or two small fragments of Zoophytes.

Drepanopsetta plattessoides (Fabr.).

The examination of twenty-two Long Rough Dabs, chiefly of small size, yielded the following results:—Four contained nothing that could be identified; *Boreophausia* sp. was found in one; *Leptomysis gracilis* (two specimens) occurred in one; and the remains of a Schizopod, the genus and species of which were doubtful, were observed in one. The remains of small Echinoderms, including a minute Echinus, the plates, pedicellariæ, and fragments of the arms of Brittle Star-fishes were obtained in the stomach of twelve of the fishes examined, while the remains of small Annelid tubes were observed in nine. A few specimens of Foraminifera, such as *Globigerina*, *Discorbina*, etc., probably derived from the worm-tubes, were also observed, but these only occurred in three stomachs. One of the fishes measured about seven inches, but the others ranged from three-and-a-half to about four-and-a-quarter inches in length.

Pleuronectes cynoglossus, Linn.

The stomachs of two Pole-dabs or Witches captured on the Fisher Bank were examined, and found to contain a considerable quantity of food; the contents of both were much alike and consisted almost entirely of small Crustaceans, and the following are the species identified:—*Diastylis resima*, *Lamprops rosea*, *Maera loveni* (fragments), *Ampelisca* sp., and the remains of one or two other Cumaceans and Amphipods. Fragments of one or two small Annelids were the only other organisms observed.

Argentina sphyræna, Lin.

A number of Argentines were captured to the eastward of the Shetland Islands in December 1901, and the subsequent examination of their stomachs showed that they had been living chiefly on small Crustacea, Star-fish, and Annelids, but the contents of a considerable proportion of the stomachs were indistinguishable. The following tabulated results will show the nature and amount of the food observed. The lengths of the fishes are in centimetres:—

Length of the Fish.	Contents of the Stomach.
20·0 centimetres.	The contents of the stomach consisted entirely of the remains of brittle starfishes (*? Amphiura*) and a small quantity of mucus.
20·5 ,,	This stomach contained nothing that could be identified.
20·5 ,,	The only organisms observed in this stomach were a single *Parathemtsto oblivia* and and a *Metopa*, the species of which is doubtful.
20·5 ,,	Five *Parathemisto oblivia*, a *Metopa* (sp. ?) and some Annelid remains.
20·5 ,,	Nothing that could be identified was observed in this stomach.
21·0 ,,	Five *Parathemisto oblivia* and some mucus.
21·0 ,,	The remains of brittle starfishes (probably *Amphiura*) were the only objects that could be determined.
21·0 ,,	This stomach contained nothing that could be distinguished.
21·0 ,,	The objects observed in this stomach were a *Philine*, probably *P. nitida*, but the shell had become too much digested for identification, and the remains of a few Chætopod Annelids.
21·0 ,,	Two *Parapleustes latipes* (M. Sacs) aud fragments of another species of Amphipod.
23·0 ,,	One *Parapleustes latipes*, a minute (young) *Astropecten irregularis*, and the remains of small Chætopod Annelids.
24·0 ,,	Four specimens of *Parathemisto oblivia* were the only organisms that could be determined in this stomach.
24·0 ,,	In this stomach there was nothing that could be identified.

Eight smaller Argentines captured on the Great Fisher Bank in June 1902 were also examined. They measured from 17 to 20 centimetres in length; the food in the stomachs of three specimens was too much decomposed for identification, two others contained fragments of Annelids, and three the remains of small Crustacea—the only form identified being a young *Pandalus*.

Argentina silus (Ascanius).

Two specimens of the Greater Argentine—one from the Fisher Bank, the other from about 57 miles north-west of the Outer Skerries, and captured in April and June 1902, were examined; they each measured about thirteen inches from the base of the tail to the anterior extremity. The only organisms in the stomach of the one from Fisher Bank, perfect enough to be identified, were a number of *Calanus*, while the food observed in the stomach of the other consisted chiefly of the remains of *Nyctiphanes*.

Raia circularis, Couch.

The stomach of a Cuckoo Ray captured at Station VI., Firth of Clyde, on October 25th, 1901, and sent to the Laboratory from the s.s. "Garland," was examined on January 16th, 1902, and the following Crustaceans, etc., were observed in it:—Remains of one or two *Hyas coarctatus*, fragments of *Stenorhynchus*; a whole specimen of *Corystes cassivelaunus*; twenty-two specimens of *Spirontocaris pusiolus*; seven specimens of *Pandalina brevirostris*, one *Virbius varians*; nine specimens of *Ampelisca spinipes*; fragments of *Amphidotus* sp., a small *Solen* sp., and a small Butterfish, *Pholis Gunnellus*; there were also a few specimens of the Annelid species, *Ammotrypane aulogoster*, and fragments of one or two other forms that could not be identified. The size of this specimen of *Raia circularis* was not stated. Another specimen of the same kind of Ray captured in the North Sea and examined on March 14th had some remains of round-fishes in its stomach, but they were too much digested for identification; this specimen measured seventeen-and-a-half inches across the pectoral fins.

Raia batis, Lin.

A specimen of Grey Skate, measuring sixteen-and-a-quarter inches across the pectoral fins, had in its stomach the remains of *Crangon allmanni*, but apparently nothing else.

Raia fullonica, Lin.

A specimen of Fuller's Ray, measuring fifteen-and-a-half inches across the pectoral fins, had also been feeding on Crustacea, but the species could not be determined.

Raia radiata, Donovan.

The stomach of a small Starry Ray was found to contain only the remains of fish too imperfect for identification.

The three fishes referred to above, which had been obtained from a trawling steamer working in the North Sea, were examined in March 1902.

Squalis acanthias, Lin.

A considerable number of Picked Dog-fishes have been examined for ecto- and ento-parasites, and as their stomachs were also examined, I append some observations on the food observed in the stomachs of these specimens. The number of specimens referred to here is twenty-two. They were captured in the North Sea, and forwarded to the Laboratory during the month of March 1902. Eight were examined on the 7th, four on the 14th, and ten on the 26th of the month.

Size of the Fish.	Contents of the Stomach.
3 feet 6½ inches.	Nothing that could be identified.
2 ,, 8½ ,,	Only the remains of round fishes.
2 ,, 7½ ,,	A moderately large Herring.
2 ,, 9½ ,,	Only two small Dabs.
2 ,, 10¼ ,,	The food was very much digested, but consisted apparently of fishes, as the two ear-stones of a small Whiting were obtained.
2 ,, 10⅓ ,,	Part of a full-grown Herring was observed.
2 ,, 9 ,,	Part of a young Coal-fish.
3 ,, 1½ ,,	The remains of fishes, but the species was not determined.
2 ,, 6 ,,	The remains of one or two Long Rough Dabs.
2 ,, 8½ ,,	The remains of fishes, but the species doubtful.
3 ,, 0 ,,	The contents of this stomach was similar to the last.
2 ,, 5 ,,	Contents similar to the last.
2 ,, 8½ ,,	Fragments of two *Gadus esmarkii*.
2 ,, 11 ,,	Two nearly whole *Gadus esmarkii* and remains of others, also a portion of the testes of a moderately large Gadoid.
2 ,, 6 ,,	The only objects in this stomach that could be distinguished were a few fish eggs.
2 ,, 8 ,,	One small *Gadus esmarkii* and the remains of another.
2 ,, 11 ,,	A Herring about 9½ inches long.
2 ,, 7½ ,,	Fragments of a Lemon Sole about 8 or 9 inches long, a Gadoid about 6½ inches, and the remains of a fish, not determined, about 9 or 10 inches long.
2 ,, 6 ,,	Fragments of a moderately large Herring and a small Gadoid.
2 ,, 6¼ ,,	Remains of a Gadoid and a Sand-eel.
2 ,, 7½ ,,	Fragments of a moderately large Herring, and some other fish remains.
2 ,, 8¼ ,,	Fragments of a large Herring, and other fish remains.

All these Dog-fishes were females. On the gills of several of them *Eudactylines* were moderately frequent, while *Tetrarhynchi* were observed in the stomachs and intestines of all but a few of those examined.

Scylliorhinus canicula, Lin.

The following three specimens of Lesser Spotted Dog-fishes were obtained among the Picked Dog-fishes just referred to. The food observed in their stomachs consisted entirely of fishes as under :—

Size of Fish.	Contents of Stomach.
2 feet 4½ inches.	A Herring 8¾ inches in length.
2 ,, 4¼ ,,	Fragments of a Herring apparently of moderate size.
2 ,, 5¾ ,,	Remains of fishes too imperfect to be determined.

A number of other fishes have been examined, including the Greater Fork-Beard *Phycis blennoides* (Brun.), the Twaite Shad, *Clupea finta*, Cuvier, and the Conger Eel, *Conger niger* (Risso), but as their stomachs did not contain any matter that could be identified they are not specially referred to in this paper. It may be remarked also that several fresh-water Perch, *Perca fluviatilis*, Rondeletius, kindly sent to me by Dr. Williamson from Marlee Loch, Forfarshire, and which were examined to ascertain the nature of their food, were found to have been living almost exclusively on insect larvæ. No parasites were observed on the gills of these fishes, but roundish sacs were frequent on the wall of the body cavity and appeared to contain encysted Cestoids.

Note on the Food observed in the Stomach of a Common Porpoise.

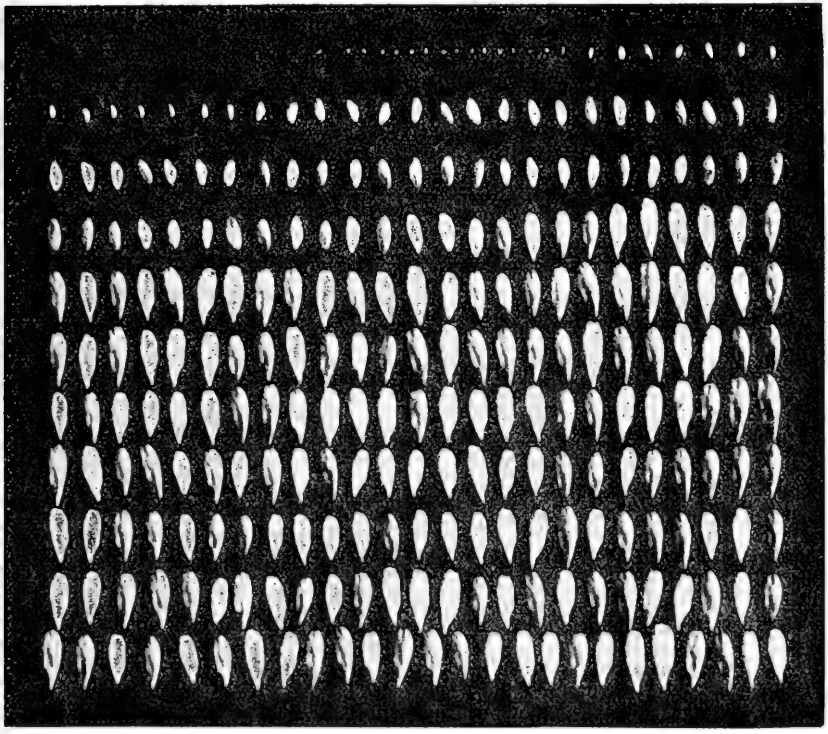
The following description of the contents of the stomach of a Common Porpoise captured in the Bay of Nigg in the vicinity of the Laboratory may be of interest, as serving to show how destructive these Cetaceans may be when they get among a shoal of fishes.

The specimen referred to had become entangled in the nets of the salmon fishers at the Bay of Nigg, and having in this way been prevented from coming to the surface for respiration had been suffocated. It was captured on the 18th of June 1902, and measured about 3 feet 9 inches in length, and it appeared to be healthy and in good condition, except that some of the passages of the liver were crowded with brownish-coloured thread-worms ; what appeared to be the same kind of worms were also found encysted in various parts of the liver, while many of them, in a "free" condition, were found in the stomach.

The only food found in the stomach consisted of the partly digested remains of fishes which, for the most part, appeared to be Whitings. Besides the remains of the soft parts of the fishes, no fewer than two hundred and eighty earstones (or otoliths) were obtained ; fully two hundred and forty of them were almost certainly those of Whitings, the majority of which represented fishes of moderate size—probably about eight inches or so in length. Twelve other otoliths were small and of an oblong form, they were not so attenuated at the ends as the typical Whiting earstone, and appeared to belong to the young of some other Gadoid ; the remainder—about twenty-two in number—were extremely small, and somewhat resembled the earstones of Sand-eels.

One or two of the largest of the Whiting earstones measured ten millimetres in length and a number of them nine millimetres, but the average length would be about eight millimetres. A considerable number of the earstones were found scattered over the surface of the stomach mixed up with the soft partly digested matter, but by far the larger number were found neatly packed together in the narrow distal end of the stomach; these earstones were remarkably clean and perfect. A few of the smaller of the Whiting earstones were slightly eroded by the solvent action of the digestive fluids. It may be mentioned that the intestines, which were of great length, contained very little matter, and no parasites were in them or in the other viscera except those already referred to.

Usually a Whiting has only two earstones, so that the two hundred and forty found in the stomach and which almost certainly belonged to Whitings represented one hundred and twenty fishes, and if each pair of the remainder represented a fish, the earstones found in this stomach would represent one hundred and forty fishes. But, while making every allowance for the voracity of these cetaceans, it is hardly likely that this



Porpoise had taken all these fishes at a single meal; but, judging from the perfect condition of the majority of the earstones, they could not have been long in the stomach. The annexed woodcut is reproduced from a photograph of the earstones as arranged and mounted on a slide.

VII.—ICHTHYOLOGICAL NOTES.

By Dr. T. Wemyss Fulton.

CONTENTS.

Sturgeon.

Sturgeons are occasionally caught in the trawl-net and brought to market, and they are as a rule taken near the land in moderate depths of water; most of those got last year were captured off the coast of Aberdeen. On 27th January one weighing $2\frac{3}{4}$ cwts. was caught fifty miles E.N.E. from Aberdeen, about thirty miles east from Peterhead, where the water, on the chart, is about sixty fathoms. Another was secured on 3rd February, which weighed 98 pounds, twenty-four miles S.E. $\frac{1}{2}$ E., in about forty fathoms. A third on 27th May 170 miles N.E. by E. from Aberdeen, in from sixty-five to seventy fathoms, nearly midway between the Orkneys and Norway, weighed three cwts. and was nine feet long by three-and-a-half feet in girth; it sold for £8 2s. Another sturgeon, a little shorter, measuring eight feet long, by three feet one inch in girth, weighed two cwts., and was caught on 29th July eighteen miles E.S.E. from Aberdeen. A fifth was taken on 20th December fourteen miles E.N.E. from Aberdeen, in from thirty to forty fathoms; it was a small specimen, weighing only forty-three pounds. A sixth was taken on 22nd December, twelve miles S. $\frac{1}{2}$ E. from Girdleness, Aberdeen, in thirty-five fathoms. It weighed seventy-seven pounds, and sold for £3 8s. The localities are indicated on the chart (Plate I., S 1–S 6).

Chimæra.

Specimens of this form are not very uncommon in the Fish-market. One was taken on 15th February, twenty-three miles east-south-east of Aberdeen, in about forty fathoms, and another by a liner, on 5th July, one hundred miles north and by east from North Ronaldshay, Orkney Islands, in deep water.

King-fish (*Lampris luna*).

Specimens of this species are also occasionally brought in by the liners working to the westwards of the Shetland and Orkney Isles. On 7th June one was caught eighty miles N. by W. from Hoy, Orkneys; on 5th July two were taken one hundred miles N. and by E. from North Ronaldshay; and on 22nd August, another, about 201

miles east from Aberdeen, on the edge of the Norwegian deep water. A specimen of the king-fish, measuring forty-one inches in length and weighing fifty-six pounds, was found lying on the beach at Usan, near Montrose, on 1st November 1902. Mr. Wm. Nisbet, the Fishery Officer, in communicating the fact, stated that no other specimen is known to have been taken in the neighbourhood since 1845, when one was caught in a salmon stake-net in the same locality.

Muller's Topknot (*Zeugopterus punctatus*).

A large specimen of this species, measuring 23·2 centimetres ($9\frac{1}{8}$ inches) in extreme length, was caught among the rocks at Peterhead on the 19th September and kindly forwarded to the Laboratory by Mr. Andrew Cowe.

The Ballan Wrasse (*Labrus maculatus*).

Two specimens were kindly forwarded by Mr. Robert Hendry, the Fishery Officer at Lerwick, which had been caught on the haddock lines a few miles off Bressay Island on 22nd November.

Bass (*Labrax lupus*).

A specimen of the bass was caught on 5th February at Kincardine-on-Forth, and kindly forwarded to me by Mr. Spowart, Bo'ness.

Mutilated Plaice.

A plaice 33 centimetres in length was taken in the trawl-net on 26th May, which had been mutilated apparently some time previously, the dorsal and ventral fins and the anal having been cut off close all round and the wound cicatrised. The fish was rather thin, but otherwise apparently healthy. It is interesting as showing the survival of a flat-fish with only the caudal fin and the pectorals.

Common or Black Sole.

On 26th April a trawler landed a number of soles, which are rare on the East Coast, estimated to weigh about a stone, taken eleven miles W.S.W. of Cape Wrath.

Norway Lobster (*Nephrops Norvegicus*).

These are sometimes taken in large numbers by trawlers. On 27th November one landed two cwts., of an estimated quantity of forty to fifty cwts., taken eighty miles E.N.E. of Aberdeen in seventy fathoms, the rest being thrown overboard, and on 5th October another landed three cwts. taken about ninety miles E.N.E., a much greater quantity having been thrown away. There is scarcely a demand for them on the market. In a haul in fifty fathoms in the Moray Firth in April two basketfuls were caught, most of them being small.

The Relative Numbers of the Sexes among Skates and Rays.

During the course of the work on trawlers a large number of rays were taken, and in many instances the proportional number of the males and

females determined. These were supplemented by similar particulars obtained by Mr. P. Jamieson at the Fish-market, and the collective results are here exhibited :—

Species.	Females.		Males.		Total No.
	No.	%	No.	%	
Grey Skate (*R. batis*), - - -	666	51·3	631	48·7	1,297
Shagreen Ray (*R. fullonica*), - -	4	50·0	4	50·0	8
Thornback Ray (*R. clavata*), - -	660	65·7	344	34·3	1,004
Sandy Ray (*R. circularis*), - -	29	61·7	18	38·3	47
Starry Ray (*R. radiata*), - - -	510	54·7	422	45·3	932

It will be observed that in no case do the males exceed the females in number, and that with the exception of the shagreen ray, where the numbers are probably too small to indicate the real proportion, the females are in excess. The amount of the excess, however, varies. There is almost equality in the case of the common skate, while with the thornback, the starry ray, and the sandy ray—although here the figures are small—the excess of females is very considerable. The measurements are scarcely sufficiently numerous to show the relative sizes of the sexes, but they suffice to indicate that the female is the larger. Thus the average breadth of forty-nine female starry rays was 26·2 cm., and the average breadth of thirty-one males 25·0 cm. Thirteen female thornbacks had a mean width of 16·1 cm., and sixteen males a mean width of 14·2 cm. Six female common skates had a mean width of 41·4 cm., and six males 37·8.

The measurements are not perhaps numerous enough to enable much to be said with regard to the rate of growth except in the case of the starry ray. I give some of the measurements of the latter arranged in centimetre groups.

[TABLE

Centimetres.	October.	November.
8-9	2	–
9-10	–	–
10-11	–	
11-12	–	–
12-13	–	–
13-14	3	–
14-15	2	1
15 16	2	–
16-17	5	2
17-18	5	1
18-19	3	1
19-20	9	4
20-21	9	5
21-22	4	8
22-23	4	–
23-24	1	3
24-25	3	1
25-26	6	6
26-27	12	11
27-28	8	5
28-29	11	10
29-30	10	14
30-31	1	9
31-32	2	3
32-33	–	–
33-34	–	–
34-35	–	–
35-36	–	–
36-37	1	–

In the October measurements, which refer to specimens taken off the Shetlands, there appear to be four groups represented, the first by two specimens 83 and 87 mm.; the second ranging from 131 mm. to 227 mm., the mean breadth being 187·6 mm. ($7\frac{3}{8}$ inches); the third measuring from 235 mm. to 315 mm., the average width being 275·1 mm. ($10\frac{13}{16}$ inches), and one specimen of 364 mm. The November measurements from the Moray Firth represent two groups, one from 145 mm. to 219 mm., the mean width across the pectorals being 193·2 mm. (or $7\frac{5}{8}$ inches), and one ranging from 233 mm. to 316 mm., the mean width being 280·5 mm. or $11\frac{1}{8}$ inches. If the limits of the groups are correct, the growth in width in a year would be about $3\frac{7}{16}$ inches in the October series and $3\frac{1}{2}$ inches in the November series; and probably this fairly well represents the actual growth of the starry ray.

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